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Articles

Investigation of Several Alleged Paleosols in the Northern Rocky Mountains Part I: Background and Methods ... 4
Peter Klevberg, Richard Bandy, Michael J. Oard

Was Charles Darwin a Racist? ... 27
Jerry Bergman

Photographic Essay: The Ultrastructure of Lichen Cells Supports Creation, not Macroevolution Part 1 ... 40
Mark H. Armitage and George F. Howe

Muscle Evolution Is a Major Problem for Neo-Darwinism: A Review ... 56
Jerry Bergman

Departments

Editorial: Creation and Public Education ... 1

Notes from the Panorama of Science
Mineral Deposits as an Example of Geological Rates ... 64
Homo floresiensis: "The Hobbit" ... 67

Letters to the Editor ... 68

Book Reviews
Pioneer Explorers of Intelligent Design by Don B. DeYoung ... 3
The Five Ages of the Universe by Fred Adams and Greg Laughlin ... 25
Science and Grace: God's Reign in the Natural Sciences by Tim Morris and Don Petcher ... 36
The Creation: An Appeal to Save Life on Earth by Edward O. Wilson ... 54
Genetic Entropy & The Mystery of the Genome—The Genome Is Degenerating by John C. Sanford ... 55
The Case for Divine Design: Cells, Complexity, and Creation by Frank B. Salisbury ... 62
Evolution's Fatal Fruit by Tom DeRosa ... 63

Instructions to Authors ... 69

Membership/Subscription Application and Renewal Form ... 71

Order Blank for Past Issues ... 72

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Haec Credimus

For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested on the seventh.—Exodus 20:11

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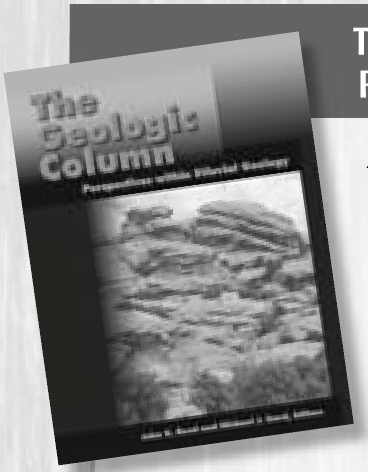
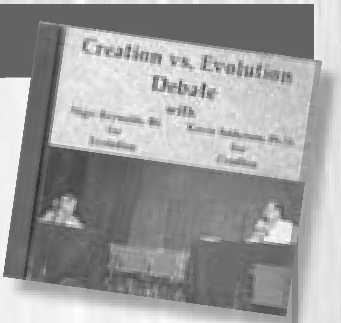


The Geologic Column: Perspectives within Diluvial Geology

John K. Reed and Michael J. Oard, Editors 2006. Creation Research Society, 157 pages. Regular price: $15.00; Member price: $11.00.

Many wonder how the evolutionary/uniformitarian geologic column fits into diluvial geology. At present, there is a remarkable diversity of original thought on this subject. Recent exchanges in the creationist literature show a tendency for various participants to talk past one another. This book has brought these different perspectives together with two goals: 1) to better define the real differences within diluvial geology, and 2) to identify the concrete issues that will provide a basis for continued research and, hopefully, future resolution. The editors went one step further by providing, at the end of most chapters, a forum with comments and responses. In addition to the editors, the other authors are: Terry Mortenson, Peter Klevberg, Carl Froede Jr., David J. Tyler, Harold G. Coffin, and Emil Silvestru. Though it may be difficult to visualize now, diluvial geology represents a major paradigm shift that holds the potential to stimulate a revolution within the earth sciences.

Creation vs. Evolution Debate



2006. Creation Research Society, approx. 45 minutes. Audio CD. Regular price: $10.00; Member price: $8.00.

Dr. Kevin Anderson (director of the Society's Van Andel Creation Research Center) squares off against local Arizona anti-creationist, Nigel Reynolds. The debate features initial arguments by both presenters followed by lively rebuttals, cross-examinations, and audience questions. This debate provides the listener an excellent opportunity to weigh the arguments of each side and seriously consider where the scientific evidence best fits.

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Editorial

Creation *and* Public Education

In 1776, fifty-six men declared that humans possess certain personal rights that are bestowed upon them by their Creator. These rights do not originate from any man-made governmental authority or decree. As such, no government can legitimately revoke these rights. Any government attempting to do so is guilty of tyranny and loses its lawful right to govern.

If you are familiar with American history, you recognize that these men were the signers of the American Declaration of Independence. Their entire justification for the American Revolution rested on the belief in a creator. This became the very foundation for the ideals of the fledgling republic.

Ironically, contemporary American public schools present a paradox to their students. They teach the Declaration (with its obvious reliance on a creator), yet subsequently teach that there is no Creator. In so doing, American educators are undermining the very pretext and foundation of the American Revolution. If no Creator exists, then there are no "unalienable rights." Human rights derive simply from other humans, and a government can give and revoke any and all rights as it chooses. Consequently, these fifty-six men had no rightful grievance against their government, nor does anyone against any government. Tyranny becomes just a word. Individual rights can disappear as suddenly as the morning mist. Do American educators really desire such a situation?

Unfortunately, this is not the only paradox and contradiction facing American students, or students in many other countries. Increasingly, educators are also taking a role in moral guidance. Yet, the morals they teach have no ultimate authority or basis. Biblical principles and a relationship with our Creator have been replaced by "tolerance" and so-called "sensitivity" training. What has been the fruit of years of this type of training? A dramatic increase in school violence, including several mass killing sprees, a dramatic increase in teenage drug addiction, a dramatic increase in teenage alcoholism, a dramatic increase in teenage sexual activity and pregnancies, a dramatic increase in … —well, I think you get the point. Moral teaching that is not ultimately founded on the authority of a creator becomes mere words. The listeners are no more obligated to abide by them than they are the words of a television commercial (and are probably less influential).

The recent shooting at one of my alma maters, Virginia Tech, all too clearly illustrates this point. As one columnist asked, who taught Mr. Cho Seung-Hui to hate? It seems that he was mocked and tormented as a young teen. Apparently his young classmates had failed to learn proper "sensitivity." What was he taught upon entering college? A glance at the course selection of the Virginia Tech English Department, where he was a major, reveals what the same columnist describes as a "wonder world of PC weirdness … a post-modern Disney World in which nihilism, moral and sexual boundary breaking, and fantasies of Marxist revolutionary violence are celebrated" (James, 2007). (My, how university English courses have changed.) And Mr. Cho was most assuredly also taught that he was a cosmic accident resulting from some uncaring evolutionary process that makes no distinction between him and the mildew in his shower.

I would ask an additional question: Was Mr. Cho ever taught to love? Was he ever taught that he was created by a great and loving Creator who loves and values him? Was he ever taught the value of human life (both his and others)? It is doubtful. Such teaching is considered "inappropriate" in the classroom. Dare we wonder why the value of human life in our society continues to be minimized? I see no reason to think that school shootings will stop.

> **Contemporary education has become more a matter of indoctrination than education.**

During his interview of me a few years ago, journalist Sam Donaldson argued that teaching creation along with evolution in public schools would present a controversy that would only confuse the students. I challenged whether the students would be very confused, but might rather enjoy tackling such a controversial topic. Do we avoid other potentially controversial topics in classrooms? Ask any student (especially college students) and you will get a clear answer of NO! Good teachers recognize that providing students with comparative and contrasting ideas often increases their understanding. Students become more focused, more engaged, and more inquisitive. How is this bad for education?

Some teachers seem to relish the idea of introducing controversial topics to their students. Unfortunately, these topics all too often deal with the more sordid side of society, such as homosexuality, bestiality, and sadomasochism. The more sordid the better, it would seem. Creation is too controversial, prayer is inappropriate, but these other topics are acceptable? And the National Education Association wonders why there are an increasing number of parents choosing to homeschool their children. It certainly seems time for a reality check.

As a college professor, I constantly encountered students who lacked critical thinking skills. They were unable to adequately process information or apply reasoning to a problem. It is not that these students were not intelligent; many were extremely gifted. They simply lacked an understanding of how to use scientific information to answer questions. Instead, they had been conditioned to merely parrot memorized lists and "facts." (Perhaps this is why fewer and fewer students are interested in pursuing scientific studies.) They were not trained to ask questions, challenged to understand the material in more detail, or taught how to draw their own conclusions. Yet, these are the very core principles of the scientific process. Science education should not only teach basic "facts," but also emphasize and explore how science is done. Instead, contemporary education has become more a matter of indoctrination than education. After all, real science education might encourage students to think for themselves. The horrible ramifications of this are obvious; at least for the evolutionists.

In fact, I would challenge that the reason evolutionists react so strongly to anything that they perceive as a "threat" to evolutionary teaching (i.e., indoctrination) is because evolutionary thinking and claims cannot survive in a scientifically competitive environment. Since when did it become poor education to allow students to understand both the strengths and weaknesses of specific scientific thinking? How is good education served by not allowing a student to introduce material from a science journal (even the journal *Evolution*) if that material supposedly contradicts the school district's official evolution curriculum? Do not give me the "song and dance" that this material would be confusing to students. Maybe Sam Donaldson would be confused, but I give students more credit. The only thing I think the students are confused about is how evolution became a constitutionally protected theory shielded from scrutiny by its own set of civil rights! Does this not contradict the very premise of scientific thought and free exchange of ideas? Does it not, in fact, contradict the very premise of education?

Evolutionists further justify their position by claiming that they are trying to protect science classrooms from the onslaught of religion. Their claim is that creation is merely religion. Thus, it belongs in the religion classroom, not the science classroom. (Interestingly, these same evolutionists tend to get upset when creation *is* taught in the religion classroom.) They justify this position by saying that creation is not science because it is not supported in the scientific journals. Coincidently, journal editors and journal reviewers argue that they will never publish a creationist article because creation is not scientific. How is it not scientific? – because it is not promoted in scientific journals. The circular reasoning becomes self-evident.

Supposedly, in today's education system we have to choose between science and God. God is considered outside the realm of science, although I have yet to hear a rational explanation of why. No, we cannot place God into a test tube and do laboratory analysis of Him. But, there are numerous phenomena in the universe that do not lend themselves to this form of analytical study. Has anyone placed "dark matter" into a chromatograph or analyzed a black hole using a mass spectrophotometer? No. Yet, evolutionary astronomers do not claim the study of dark matter or black holes to be unscientific nor outside the boundaries of science. The late Dr. Carl Sagan (noted for his TV presentations of evolution) studied astrobiology, i.e., the study of extraterrestrial life. Now, has anyone yet found extraterrestrial life? Again, the answer is no. So, in other words, Dr. Sagan did "scientific" study of something that has not yet been found. Did any evolutionists say his work was not scientific?

Many aspects of the universe cannot be directly studied, but their attributes and influences on other systems can be studied. Such is it with a creator as well. Creation scientists have consistently explained how science can study and examine the Creator through observation and understanding of His creation. For example, the sequencing of the human genome, and now dozens of other genomes, provides an excellent opportunity for an even deeper insight into the wonders and character of the Creator.

I think the real reason for exclusion of creation from the science classroom has little to do with mixing religion with science. Religion is already being taught in the science classrooms. It is called *evolutionism* (Anderson, 2007). Evolutionism is an intolerant religion that worships a jealous god. Poised under the fraudulent title of "science," the religion of evolutionism seeks to replace all other "gods." Occasionally an evolutionist will even admit this, such as Carolyn Porco's admission that

> if anyone has a replacement for God, then scientists do. At the heart of scientific inquiry, is a spiritual quest … Science provides an aesthetic view of the cosmos that could replace that provided by religion. (Brooks, 2006, p. 8)

Actually, science is not a replacement for anything (replace the word science with *evolutionism* in the above quote to see Dr. Porco's real intent). Science is merely a tool humans use to study the world around us. It neither speaks nor reacts. It is not aesthetic. Like a hammer or a computer, it is a tool wielded by humans, and the results completely depend on how well the human utilizes the tool. Science draws no conclusions; humans do. Ultimately, it is not a matter of science vs. creation, or science vs. religion, or science vs. anything. It is merely the opinion of certain scientists vs. creation or the opinion of certain scientists vs. the opinion of other scientists. Once this is finally recognized, maybe the sinking ship of public education can begin to right itself and sail forward again.

Anderson, K.L. Science vs. evolutionism. *Creation Research Society Quarterly* 43:201-203.

Brooks, M. 2006. In place of God: can secular science ever oust religious belief—and should it even try? *New Scientist* 192:2578:8-11.

James, L. 2007. Was Cho taught to hate? http://www.americanthinker.com/blog/2007/04/was_cho_taught_to_hate.html

Book Review

Pioneer Explorers of Intelligent Design

by Don B. DeYoung

BMH Books, Winona Lake, IN, 101 pages, $12.99.

This fascinating book looks at 144 scientists of the past and the contributions they made to the world of science, as well as their personal testimonies. The book is divided into eight chapters by subject—Astronomy, Earth Science, Exploration, Life Science, Mathematics, Medicine, Physical Science, and Missing Persons. The biographies highlight key points and discoveries from each person's life, and discuss each one's relationship to the Creator. The list of names includes well-known personalities such as Max Planck, founder of quantum mechanics, and Christopher Columbus. It also contains some lesser-known but still important individuals such as Peter Waage, a pioneer chemist and mineralogist, and Robert Grosseteste, who experimented with light.

It came as a surprise while reading this book to find out that the majority of early members of the Royal Society were Puritans. That modern science is founded upon the work of those who were devoted to the study of their Creator as well as science is clearly shown throughout the book.

One section that I thought was especially interesting was the section called "Missing Persons." This chapter discusses the lives and accomplishments of some notable non-Christian scientists such as Marie Curie and Stephen Gould. These men and woman often spent their lives looking for purpose and meaning, but apparently never came to the Creator. I think that this book demonstrates that they are the exception, rather than the rule, in the history of scientific inquiry.

The book contains an appendix of names mentioned in Henry Morris's similar book entitled, "Men of Science, Men of God," a list of references, and Scripture and name indices.

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Investigation of Several Alleged Paleosols in the Northern Rocky Mountains

Part I: Background and Methods

Peter Klevberg*, Richard Bandy, Michael J. Oard

Abstract

The existence of paleosols, "fossil soils," is a popular argument of anticreationists. Paleosols have been reported from several locations east of the Rocky Mountains in northern Montana, U.S.A., and southern Alberta, Canada. These alleged paleosols have been correlated between erosional remnants corresponding to the Flaxville Plain, an extensive surficial planar erosion surface, and dated by correlation to magnetic reversals. A chronology of 2.6 million years has been presented in the literature, with multiple glaciations, paleogeographic and paleoclimatologic reconstructions. The first part of this series presents background, methods, and a description of field sites where these alleged paleosols are found, including field data. The second part will present laboratory data and a discussion of field and laboratory data from both the traditional and diluvial perspectives.

The Apparent "Problem" of Paleosols

Because the traditional understanding of paleosols conflicts with the biblical timescale and history, "paleosols" are a favorite "proof" used by some anticreationists (Klevberg and Bandy, 2003a; Klevberg et al., 2003; Walker, 2003). This "proof" rests on the following claims:

- Soil formation is a slow process, requiring thousands to millions of years.
- Paleosols are present throughout the geologic column (equated to rock record)
- Successions of paleosols (vertical sequences) require in excess of the additive time for the formation of each paleosol.
- Paleosols are indicative of subaerial conditions and thus inimical to a global flood (since they occur throughout the global stratigraphic column)

The first claim is an assumption. Klevberg and Bandy (2003a; 2003b) have shown that soil formation can happen much more rapidly. Second, many horizons identified as paleosols in the rock record are very tentative (Klevberg et al., 2003). In addition, the geologic column (by definition) is a natural history paradigm, indefensible on solely scientific grounds. Equating the geologic column with the physical phenomena it is intended to interpret is a tautology and a grave error philosophically, historically, and scientifically (Klevberg, 1999; 2000a; 2000b; Reed and Oard, 2006; Woodmorappe, 1981). Therefore, the supposed distribution of paleosols through time is also open to question. Furthermore, the vast ages inferred from successions of "paleosols" depends on both the veracity of the paleosol interpretation of a horizon in the rock record and the assumption of slow pedogenesis. The fourth claim may be problematic for diluvialists. Not all soils form under dominantly subaerial conditions, but certainly most do. While not all of the earth's surface

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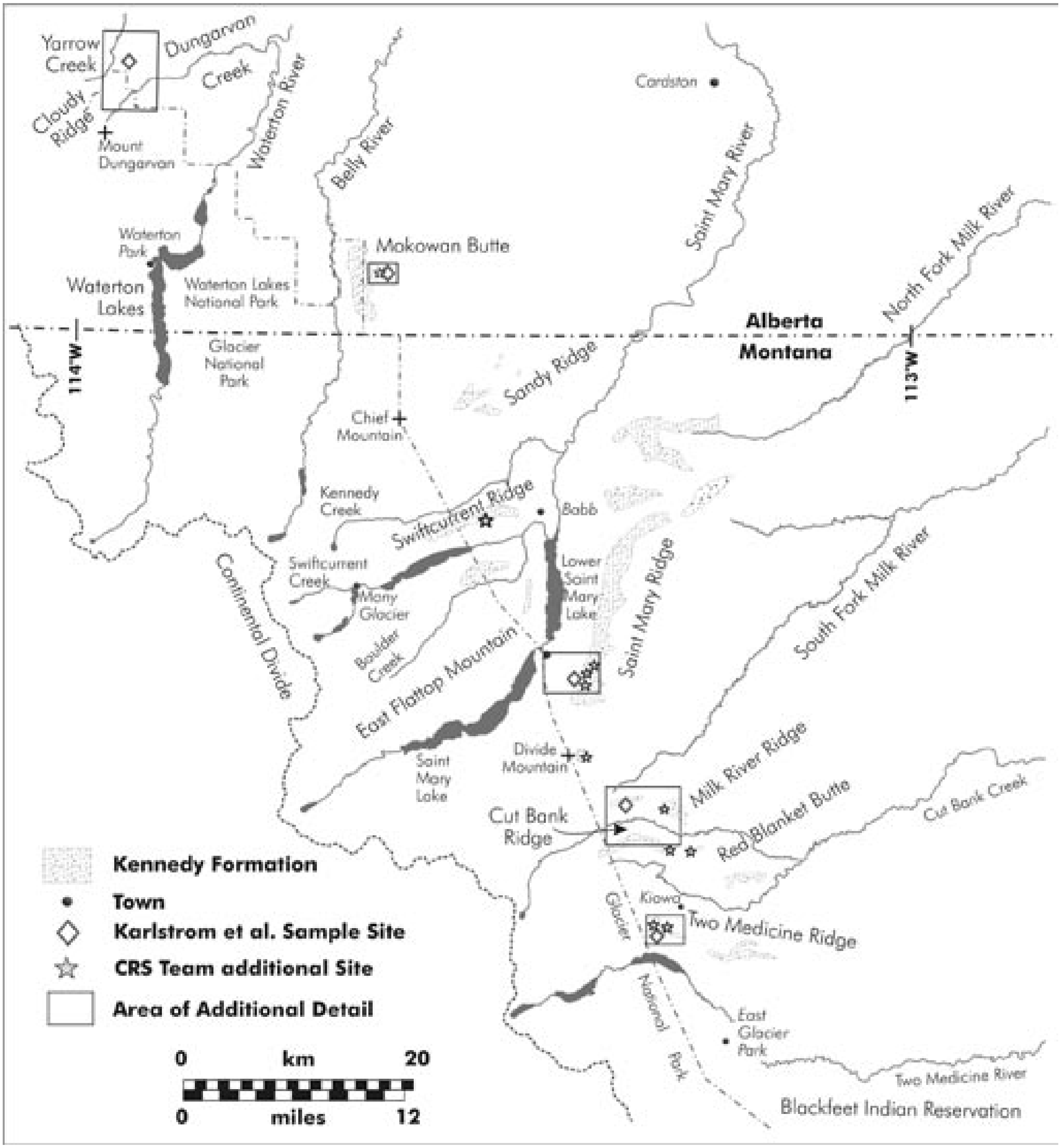


Figure 1. Map of Study Area.

would have been continuously submerged for the entire Deluge (Barnette and Baumgardner, 1994), abundant paleosols would not be expected to form during a global flood. The anti-creationist Meerts (2006) noted on a website posting that, "Obviously there is no chance for mature and thick soils to form during a global tempest such as the flood of Noah."

How can diluvialists explain paleosols? Do "paleosols" indicate the passage of vast periods of time? Do they actually provide the evidence for past climate change, geography, and biology that many establishment researchers claim? What are the scientific data, and how do they compare with expectations based on biblical presuppositions? While previous papers addressing paleosols have approached the issue in general or theoretical terms (see Froede, 1998, pp. 21–28; Klevberg et al., 2003; Oard, 1990, pp. 151–159), this series will focus on a field investigation and the interpretation of those results within opposing worldviews.

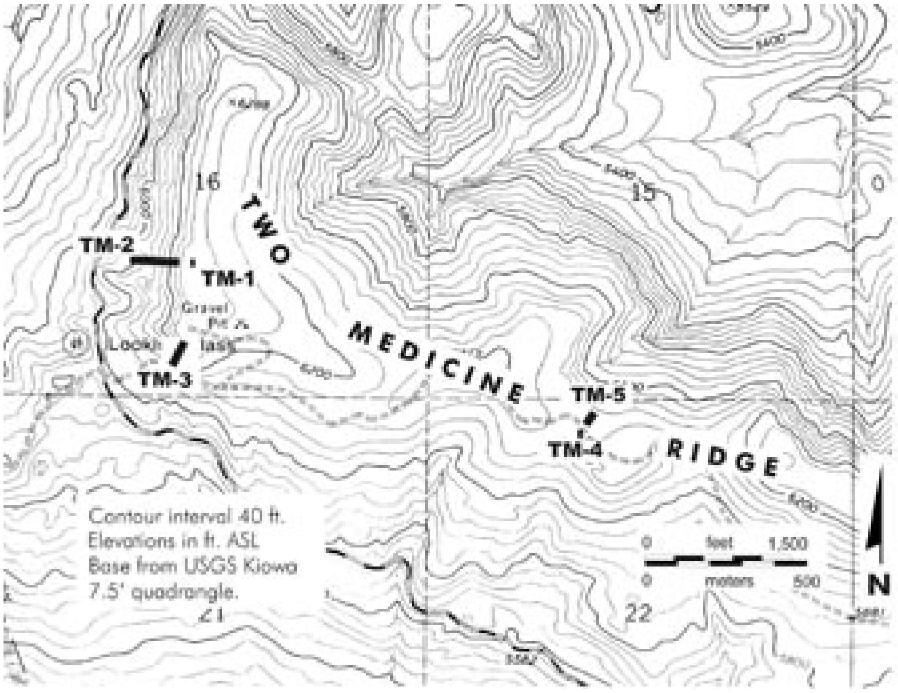


Figure 2. Two Medicine Ridge Sample Map.

Paleosol Investigation in the Northern Rocky Mountains

Applying principles from Klevberg and Bandy (2003a, 2003b), Klevberg et al. (2003), and Klevberg and Oard (2005), we examined alleged paleosols in northern Montana and vicinity, focusing on those of the Kennedy "drift." These have been recognized for many years, have been the subject of previous investigations and many published papers, and are found within a geologic setting familiar to us (Cioppa et al., 1995; Horberg, 1956; Karlstrom, 1982; 1988; 1990; 1991; 2000; Karlstrom and Barendregt, 2001; Klevberg and Oard, 2005; Richmond, 1957; 1986). These paleosols(?) are claimed to separate "late Pliocene ice ages" up to 2.6 million years old, and lie on erosional remnants just east of Glacier National Park, Montana, and Waterton National Park, Alberta, Canada (Figure 1). We also evaluated the relationship of these deposits to other gravel-capped erosional remnants farther out on the high plains.

Since investigations into natural history are by definition mixed question (requiring multidisciplinary input from fields other than science), conclusions about paleosols are ultimately historical, not scientific (Klevberg and Bandy, 2003b; Klevberg et al., 2003). Science can constrain interpretation, but a careful distinction must be made between data and interpretation, a distinction often lacking in both evolutionist and creationist research. While evolutionists' interpretations involve a timescale incompatible with biblical history, paleosols per se are not inimical to a diluvial interpretation, and it was not our goal to "disprove" their existence. Rather, our purpose was to distinguish between data and interpretation in the work performed by previous researchers and to conduct enough field and laboratory research to test the validity of their data and elucidate remaining uncertainties.

The Kennedy "Drift" and "Paleosols"

Paleosols separate what are considered glacial tills on generally flat-topped interfluves east of Glacier and Waterton National Parks (Karlstrom, 1988). These interfluves are 185 to 490 m (600 to 1,600 ft) above rivers and streams draining the east slopes of the Rocky Mountains (Figure 1), and are erosional remnants of the Flaxville planation surface in northern Montana, southern Alberta, and southwestern Saskatchewan (Alden, 1932; Karlstrom, 1982). This surface was recognized by Willis (1902) and Ross (1959) as the "Blackfeet surface," but Alden (1932), working from the east, correlated it with erosional remnants he first encountered near Flaxville, Montana. The Flaxville surface is the second highest of four defined by Alden (1932), all mantled by exotic coarse gravel. The Cypress Hills surface is the highest in the area and corresponds locally to East Flattop Mountain (Figure 1). The coarse gravel caps have been transported at least 700 km (400 miles) eastward on a low slope (Klevberg and Oard, 1998; Oard and Klevberg, 1998).

The Flaxville surface shows slight disparities in summit concordance and is at a slightly lower level than East Flattop Mountain. Its gravel cap was considered fluvial by Bailey Willis (1902), but Alden (1932), who renamed the deposit the "Kennedy Drift" from Willis's "Kennedy gravels," believed it to be glacial because of striated clasts (Figure 2). He considered the deposits "old" because the surrounding area had been eroded up to 490 m (1,600 ft) since that ice age. Despite a lack of contrast between clearly fluvial and "glacial" deposits, the glacial interpretation was widely accepted (Ross, 1959) and still is. The interfluves were above the Cordilleran and Laurentide Ice Sheets (Pleistocene, see Horberg, 1956). In the diluvial framework, the glacial deposits would correspond to the single postdiluvial glaciation (Oard, 1990). The thickness of the coarse gravel ranges up to at least 75 m [250 ft] (Horberg, 1956).

With the exception of a minor amount of the "Cretaceous" sandstone below the gravel, the "drift" is composed almost exclusively of "Precambrian" Belt Supergroup rocks from the mountains to the west (Cannon, 1996; Hobbs, 1984; Roberts, 1986; Ross, 1959). The "drift" includes argillite, quartzite, limestone, dolostone with minor diorite, and possibly basalt or metagabbro from sills and dikes. Some of the "drift" is cemented by calcium carbonate, forming conglomerate (Figure 3). In general, the diamicton is considered a till, and is cemented in places.

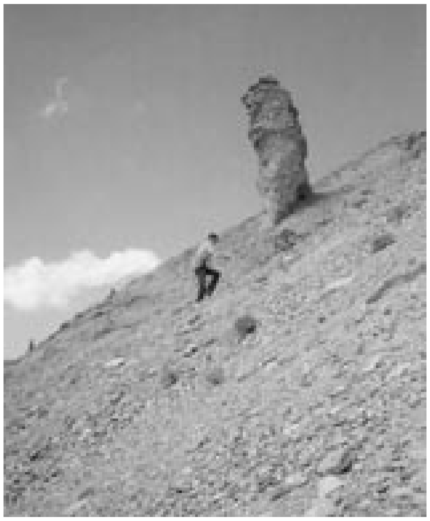


Figure 3. The "classic slope" on Two Medicine Ridge (southwest slope).

A Tale of One-Five-Ten Paleosols

Horberg (1956) noted that the "drift" has been "weathered" to an unusual depth. He correlated the "weathered till" to the "known" climatic event of the "Yarmouth Interglacial" (Table I). He saw no evidence of a warmer and more humid climate from the weathering profile, although he noted that the "weathering profile" would have taken considerable time to develop. Later, Richmond (1957) and Karlstrom (1987; 1988; 1991) saw at least five, and possibly ten, strongly developed paleosols between five tills on two of the interfluves, and lesser numbers on the others. Furthermore, Karlstrom (1991) claimed that the paleosols represent interglacials at least 6 to 8°C warmer and 40 cm (16 in) wetter than the present climate. In contrast, the climate of each ice age was at least 10°C colder than today, based on relict periglacial features on some of the "tills" (Karlstrom, 1990). The Kennedy "drift" has been paleomagnetically dated to as old as 2.6 Ma—late Pliocene in the establishment geologic paradigm (EGP)—and is considered one of the oldest tills in North America (Cioppa et al., 1995). Magnetostratigraphy and pedostratigraphy have been used to correlate paleosols(?) between five sites over a distance of approximately 75 km (45 miles) to arrive at a more "complete" history of the area, including paleoclimate (Karlstrom, 1988).

If EGP researchers are correct in their interpretation of the Kennedy Formation, it would bolster the evolutionist-uniformitarian view of earth history. This view is incompatible with the biblical-diluvial view of earth history in several ways:

- An age of 2.6 Ma is not compatible with biblical chronology.
- Multiple ice ages fit poorly with the shorter time period indicated by biblical history.
- Multiple magnetic reversals reportedly recorded in the Kennedy Formation are not inimical to the diluvial geologic paradigm (DGP), but may fit better with the EGP.
- An age of 2.6 Ma implies soil development (pedogenesis) is relatively slow, and multiple superposed paleosols would imply a vast age.

However, these issues are merely inferences from geologic data. It is important to determine what the field data are and which geologic paradigm (if either) they may be understood to favor. Science is an invaluable tool in testing these disparate claims.

Table I. "Classical" Four Ice Age Scheme

Glacial	Years B.P.*	Interglacial
Wisconsinan	100,000–10,000	
	225,000–100,000	Sangamon
Illinoian	325,000–225,000	
	700,000–325,000	Yarmouth
Kansan	1.1–0.7 Ma	
	1.2–0.7 Ma	Aftonian
Nebraskan	1.6–1.2 Ma	

*Evolutionists differ significantly on these fictional dates.

Research Methods

Alleged paleosols have been identified at Two Medicine Ridge (Horberg, 1956; Richmond, 1957; 1986) and at four other sites (Karlstrom, 1988; 1990; 1991). To the extent feasible, both a geological engineer and a soil scientist from our group (CRS team) examined each of these sites (Figure 1). In addition, at least one member of our team examined each of 11 other Kennedy Formation sites not previously published (Figure 1). Until recently (Karlstrom and Barendregt, 2001), locations of the sites investigated by Karlstrom were not well documented, but we are confident that we located nearly all of his test trenches.

In addition to reopening his trenches, we dug additional test pits nearby. Our soil scientist described their soil profiles using U.S. Department of Agriculture nomenclature (Soil Survey Division Staff 1993; 1999). Our geologist/engineer classified unconsolidated materials using the Unified Soil Classification System (ASTM, 1992) and consolidated materials using petrologic terminology. Soil samples collected from several pits and trenches were submitted to Continental Rocktell Services of Calgary, Alberta, for thin section, petrologic, and electron microscopy analysis. Most were oriented samples. Our field research gathered and evaluated a significant quantity of data, and a detailed description of methods is presented in Appendix A. Pedologic and geologic data are displayed on test pit and slope logs in Appendix B. The following sites can be found by reference back to Figure 1.

Research Sites

Two Medicine Ridge

Two Medicine Ridge is the "original" paleosol site. The area described by previous investigators coincides with our test trench TM-3 (Figure 2). In addition to that location, we dug a series of test pits that included: TM-1, a test pit on top of the ridge; TM-2, a series of pits down the west side; TM-4, another ridge top test pit east of TM-3, and TM-5, a scarp trench farther east along the ridge. A summary of soil classifications for the materials encountered in test pits and trenches is presented in Table II. Slope logs can be seen in Appendix B. The southwest slope of Two Medicine Ridge is the only site included in this study virtually devoid of evidence of modern pedogenesis.

Table II. Two Medicine Ridge Soils

Test Pit or Trench	Classification
TM-1 (0')	Loamy-skeletal, mixed, superactive, ustic haplocryalfs
TM-2 (2')	Loamy-skeletal, mixed, superactive, ustic haplocryalfs
TM-2 (70')	Typic cryopsamments
TM-2 (148')	Sandy-skeletal, mixed, typic cryorthents
TM-2 (266')	Loamy-skeletal, mixed, superactive, ustic, typic cryorthents
TM-2 (363')	Fine-loamy, mixed, superactive, ustic haplocryalfs
TM-2 (479')	Loamy-skeletal, mixed, superactive, lithic haplocryolls
TM-3	Sandy-skeletal, mixed, typic cryorthents
TM-4	Clayey-skeletal, mixed, superactive, ustic glossocryalfs
TM-5 (2')	Clayey-skeletal, mixed, superactive, ustic glossocryalfs
TM-5 (3')	Clayey-skeletal, mixed, superactive, inceptic haplocryalfs
TM-5 (16')	Loamy-skeletal, mixed, superactive argicryolls
TM-5 (19')	Loamy-skeletal, mixed, superactive argicryolls
TM-5 (22')	Loamy-skeletal, mixed, superactive argicryolls

The soil in TM-1 was that expected for nearly level slopes or slopes without a long history of pedogenesis. The A horizon is 15 cm (6 in) deep with a B_t argillic horizon extending to a depth of at least 43 cm (17 in). This indicates a well-developed soil with a deeper moisture control section, indicative of a fairly high effective precipitation rate that would allow for deeper leaching. Downslope to the west (TM-2), we found little evidence of any kind of argillic horizon in the soil pits, as expected for steep slopes with little vegetation to slow water movement across the surface, and allow leaching. As the slope angle lessened down TM-2, the slope became more stable with more vegetation, and argillic horizons were found. This corresponds to the local climate: runoff from snowmelt and high-intensity rainfall on steep slopes increases erosion. Since soil moisture levels rarely get to the saturation point, vegetation is sparse, and organic matter that would improve fertility cannot accumulate. As the slopes decrease, less runoff and more water percolation into the soil occur. Erosion decreases, vegetation increases, fertility increases, and colonization by more climax type species occurs.

The "classic" location on Two Medicine Ridge is the scarp on the southwest side at TM-3 (Figure 3). The slope has a southwest aspect and is virtually devoid of vegetation. It is steeper than the west slope, averaging roughly 36° from the horizontal. Its surface is covered with coarse colluvium (talus) with outcrops of carbonate-cemented conglomerate of the same composition—the suite of lithologies typical of the Kennedy Formation. Bedding is sometimes evident in the conglomerate—sometimes paralleling the slope, and sometimes horizontal. Iron oxide coats some of the clasts. Evidence of soil formation near TM-3 was almost nonexistent, with an obvious lack of clay films and with material that would be considered B_k or C intermixed with boulders and coarse rock fragments. An exception was observed approximately 3.6–4.6 m (12–15 ft) vertically below the top of the ridge, where argillic material was encountered that proved to be colluvial. Further investigation disclosed an argillic (B_t) horizon approximately 2.1 m (7 ft) below the ridgetop. Both the argillic material and colluvial sand downslope exhibited red coloration; however, no evidence was apparent for a pedogenic origin of the iron oxide in the colluvium.

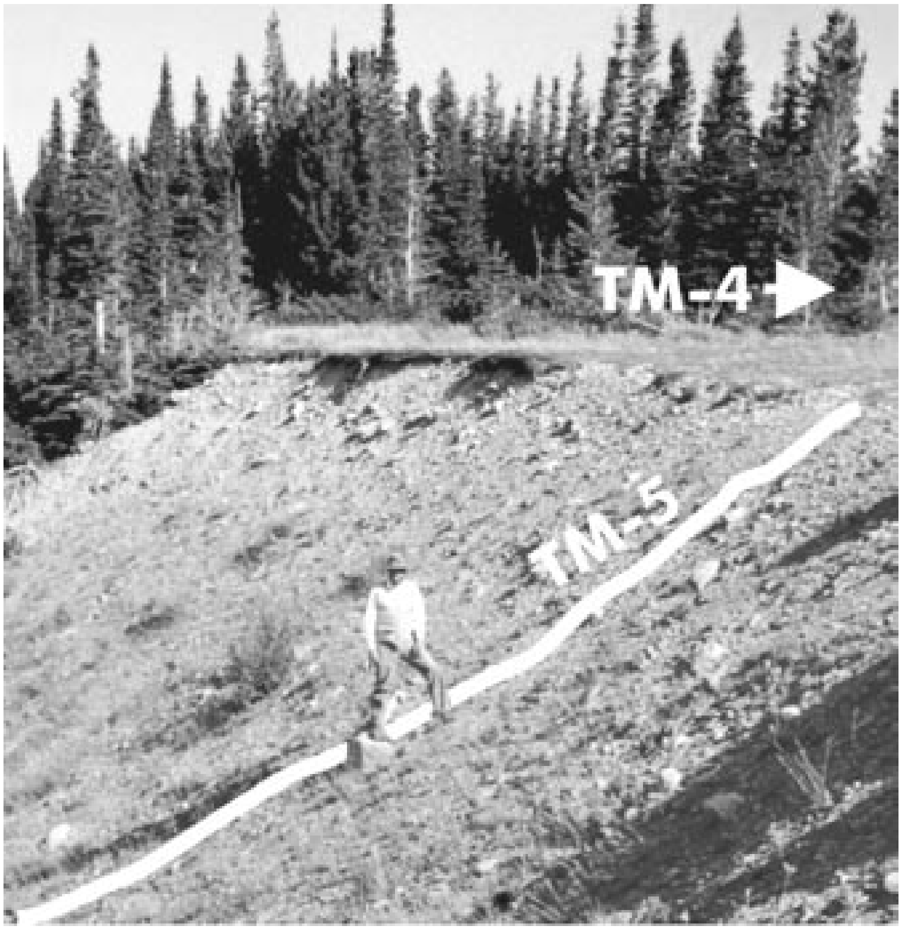


Figure 4. North-facing scarp on Two Medicine Ridge (test trench indicated).

TM-4 and TM-5 are 1.6 km (1 mi) east of the "classic" scarp (Figure 3). TM-5 occupies what appears to be a rather recent scarp (Figure 4). Seedlings there appeared to be no more than 3–5 years old. The slope aspect is north, and the north slope of the ridge is forested with Engelmann Spruce (*Picea engelmannii*) and Sitka Alder (*Alnus sitchensis*). The scarp was well vegetated with cow parsnip (*Heracleum lanatum*), yellow Indian paintbrush (*Castilleja sessiliflora*), and various forbs and grasses. The top of the ridge, which is exposed to more sun and wind than the north-facing slope, is entirely covered with grasses except for a few battered Whitebark Pine (*Pinus albicaulis*) along the edges of the rather flat ridge top. TM-4 showed what appeared to be a well developed alfisol with an E horizon to the bottom of the pit at 0.45 m (1.5 ft), corresponding to the profile evident in TM-5, where an argillic horizon was encountered below an A horizon and a leached E horizon 0.75 m (2.5 ft) vertically below the top of the scarp.

This site was significant in forming our ideas about the paleosols(?) in the Kennedy Formation. The argillic horizon observed in TM-5 is quite thick and deep, typical of a relatively moist, forested site with good leaching characteristics. The elevation of the site produces a cool climate with much of the moisture derived from snowmelt. Where carbonate content is low, the Kennedy Formation is quite permeable, promoting water movement and clay translocation (Klevberg and Bandy, 2003b). Trees help prevent moisture loss from the surface and allow meteoric water to penetrate, leaching organic acids from leaf litter to more rapidly produce an eluvial (E) horizon, and depositing clays (mostly physils) in the subjacent illuvial (B_t) horizon. On the slope surface in colluvium, an A horizon overlies the argillic horizon to its maximum extent below the ridge top. Material below the argillic (B_t) horizon appeared to be Kennedy Formation to a depth of approximately 8 m (25 ft), where float indicated the presence of sandstone, which resembled strata outcropping at the northwest end of Two Medicine Ridge.

Milk River Ridge (West)

Milk River Ridge is cut by a saddle into west and east halves. The scarp on the west end has a southeasterly aspect (Figure 5). While some of the CRS team members had previously performed a reconnaissance of the adjacent slope,

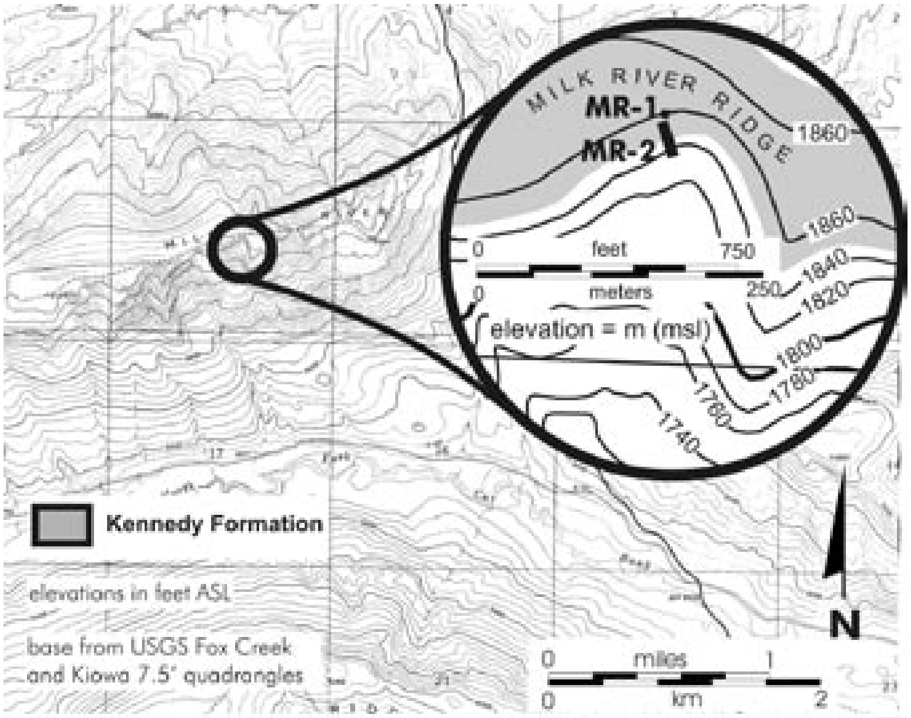


Figure 5. Milk River Ridge Sample Map. Topography from USGS Fox Creek and Kiowa 7.5' quadrangles.

the information here is primarily from the scarp studied by Karlstrom (1988; 1990; 1991). In addition to reopening his test trench (our MR-2), we excavated a test pit on the ridge top near the head of the scarp (MR-1). Soil classifications for materials encountered at the landslide scarp on the south side of the west part of Milk River Ridge are shown in Table III. Soil development has occurred at a rate adequate to produce well-developed soils. The presence of a strongly developed E horizon on top of the ridge indicates an environment conducive to leaching. The ridge crest is quite flat and well forested with conifers (principally Lodgepole Pine, *Pinus contorta latifolia*). Movement of water from snowmelt and rainfall through the soil profile translocates primary minerals and clays deeper into the soil profile. This is enhanced by production of organic acids from leaf litter and other organic matter. A reduction in permeability and slowing of water movement results in deposition of clays beneath the eluvial (E) horizon, forming an argillic (B_t) horizon to a depth of at least 50 cm (20 in) in the vicinity of MR-1.

Table III. Milk River Ridge (West) Soils

Test Pit or Trench	Classification
MR-1	Clayey-skeletal, mixed, superactive ustic glossocryalfs
MR-2 (5')	Clayey-skeletal, mixed, superactive ustic glossocryalfs
MR-2 (10')	Clayey-skeletal, mixed, superactive, ustic haplocryalfs
MR-2 (15')	Clayey-skeletal, mixed, superactive, ustic haplocryalfs
MR-2 (20')	Clayey-skeletal, mixed, superactive, ustic haplocryalfs
MR-2 (25')	Clayey-skeletal, mixed, superactive, ustic haplocryalfs
MR-2 (30')	Clayey-skeletal, mixed, superactive, ustic glossocryalfs
MR-2 (35')	Clayey-skeletal, mixed, superactive, ustic haplocryalfs
MR-2 (40')	Clayey-skeletal, mixed, superactive, ustic haplocryalfs
MR-2 (45')	Clayey-skeletal, mixed, superactive, ustic haplocryalfs
MR-2 (55')	Clayey-skeletal, mixed, superactive, ustic eutrocryepts
MR-2 (62')	Clayey-skeletal, mixed, superactive, ustic eutrocryepts
MR-2 (70')	Clayey-skeletal, mixed, superactive, ustic eutrocryepts
MR-2 (80')	Clayey-skeletal, mixed, superactive, ustic glossocryalfs

Figure 6. Dictating field notes while excavating Karlstrom's trench on Milk River Ridge (trench MR-2).

Down slope (MR-2), we encountered a relatively thick A horizon in our shallow test pits within and beside Karlstrom's trench (Figure 6), probably due to colluvial accumulation from upslope sources. These were underlain by B_t horizons approximately 25 cm (10 in) thick. At the toe of the scarp, where MR-2 entered timber, E horizons appeared above the argillic horizons, and A horizon material appeared more intact rather than colluvial. Limonite and other combinations of hydrous oxide minerals, which were evident in the near surface soil along the scarp, were not evident below the toe of the scarp.

The soils observed on the slope could be expected on a well-vegetated, stable slope, where deep leaching would promote formation of prominent argillic horizons. Loss of forest cover to disease, insects, fire, or logging may result in destabilization of the slope and soil erosion. Soil formation is ongoing on the slope, based on the cumulic A horizon and secondary minerals, though erosion on the unstable slope constantly disrupts the formation of the soil profile. A well-developed alfisol is present above and below the scarp. Slope logs can be seen in Appendix B.

Saint Mary Ridge

The largest of the sites investigated is Saint Mary Ridge. Three landslide scarps are prominent on its west side. The middle scarp was investigated by Karlstrom and was the primary focus of our investigation. However, before examining the scarp, we excavated three test pits in the forested top of the ridge (Figure 7). To the extent feasible, we located Karlstrom's previous test trenches and designated ours with Arabic numerals corresponding to his Roman numerals (e.g. his Trench V corresponds with our SM-5). Their locations are shown on the inset of Figure 7. Soil classifications are summarized in Table IV; test pit and slope logs can be seen in Appendix B.

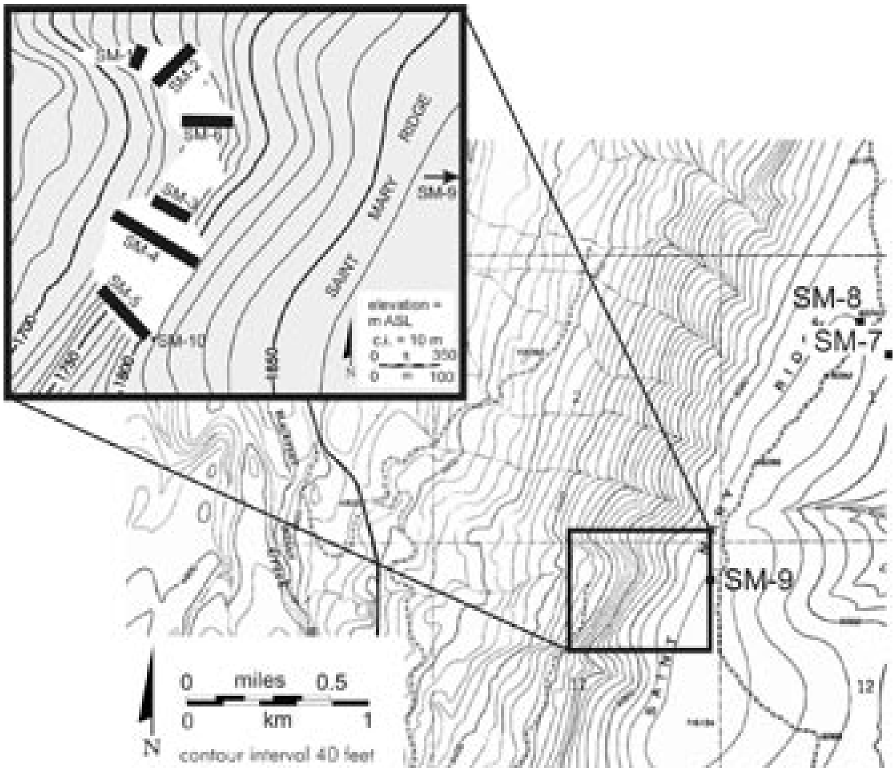


Figure 7. Saint Mary Ridge Sample Map. Base from USGS Saint Mary 7.5' quadrangle.

Before examining the test trenches, we excavated an additional test pit (SM-10) just above the top of the scarp (Figure 7). In SM-10, we found a well-developed alfisol with a 5-cm (2-in) thick O horizon atop a 75 cm (30-in) E horizon, above an argillic horizon, indicating a moist, stable environment where rainfall and snowmelt percolate into rather than erode the soil. Adequate effective precipitation; smooth, low slopes; a canopy of trees; and the soil texture combine to produce a leaching environment, effecting translocation of clay particles from the E horizon into the B_t horizon.

Downslope from SM-10, the slope becomes unstable (Figure 8). Runoff from snowmelt and rain erode the soil, minimizing vegetation, infiltration, and thus soil formation. Examination of the soil on the scarp confirmed this. Thin A horizons are present with (in most cases)

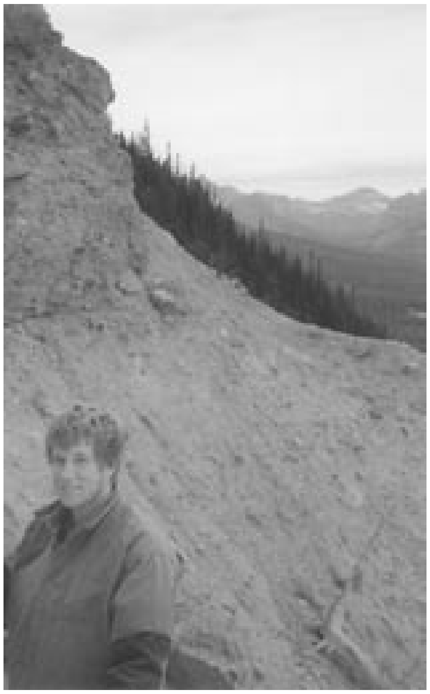


Figure 8. Unstable slope (center scarp), Saint Mary Ridge.

Table IV. Saint Mary Ridge Soils

Test Pit or Trench	Classification
SM-1	Entisol, unclassified
SM-2 (115')	Coarse-loamy, mixed, ustic, eutrocryepts
SM-3 (0')	Sandy-skeletal, mixed, ustic calcicryolls
SM-5 (5')	Clayey-skeletal, mixed, superactive, ustic glossocryalfs
SM-5 (20')	Loamy-skeletal, mixed, superactive, typic eutrocryepts
SM-5 (30')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (40')	Loamy-skeletal, mixed, superactive, ustic eutrocryepts
SM-5 (50')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (60')	Fine-loamy, mixed, superactive, ustic eutrocryepts
SM-5 (70')	Fine-loamy, mixed, superactive, ustic eutrocryepts
SM-5 (80')	Loamy-skeletal, mixed, superactive, ustic eutrocryepts
SM-5 (90')	Loamy-skeletal, mixed, superactive, ustic eutrocryepts
SM-5 (100')	Loamy-skeletal, mixed, superactive, ustic eutrocryepts
SM-5 (110')	Loamy-skeletal, mixed, superactive, ustic eutrocryepts
SM-5 (120')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (130')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (140')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (157')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (160')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (170')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (180')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (190')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (200')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (240')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (260')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (300')	Loamy-skeletal, mixed, superactive, ustic eutrocryepts
SM-5 (320')	Loamy, mixed, superactive, lithic cryorthents
SM-5 (335')	Heavy clay loam with 40–50% coarse frag., violently eff.
SM-6 (80')	Loamy, mixed, superactive, lithic cryorthents
SM-6 (180')	Loamy-skeletal, mixed, superactive, ustic eutrocryepts
SM-7	Fine-loamy, mixed, superactive, inceptic haplocryalfs
SM-8	Fine-loamy, mixed, superactive, inceptic haplocryalfs
SM-9	Fine-loamy, mixed, superactive, aquic haplocryalfs
SM-10	Clayey-skeletal, mixed, superactive, ustic glossocryalfs

a B_k or C horizon directly beneath. In only one location (SM-5 at 50 feet) did we find evidence of formation of a B_t horizon (though argillic material was occasionally present in colluvium). This escarpment showed predictable soil development. Applying the five environmental factors and four soil-forming mechanisms (Klevberg and Bandy, 2003a), the slope above the landslide scarp is a strong leaching environment where well-developed soils would be expected, while the steep and unstable slope limits soil formation. Nonetheless, with the exception of lithified portions of the scarp (Figure 9), evidence of nascent pedogenesis was observed in the unstable colluvium.

Mokowan Butte (Pole Heaven)

Pole Heaven is an area on the northeast flank of Mokowan Butte near the summit flat. In addition to the landslide scarp and road cut investigated by Karlstrom, the CRS team excavated test pits in other locations (Figure 10). Slope logs can be seen in Appendix B. Mokowan Butte is well forested, and much of Pole Heaven has been logged in recent years. Soil classifications for materials encountered are shown in Table V. The first test pit (PH-1) was in a well-vegetated area near the edge of a clear-cut. It revealed a well-developed, productive alfisol, typical of forested terrain in this climate. Test pits PH-2 through PH-5 form a test trench near the west end of a small landslide scarp near the northeast edge of the top of the butte. PH-2 was excavated in the forested edge above the scarp, and a B_t horizon was encountered at a depth of 51 cm (20 in). This indicates a stable landscape with high effective precipitation, resulting in significant leaching and physical weathering (translocation of clays), producing an argillic horizon beneath the E horizon. Based on observations of PH-1 and PH-2, we infer that well-developed alfisols can be expected on stable slopes with heavy vegetation. Since soil formation is evident on most

Table V. Mokowan Butte (Pole Heaven) Soils

Test Pit or Trench	Classification
PH-1	Fine, smectitic, superactive, alfic argicryolls
PH-2	Fine, smectitic, superactive, ustic glossocryalfs
PH-3	Fine, smectitic, superactive, ustic haplocryalfs
PH-4	Fine, smectitic, superactive, ustic haplocryalfs
PH-5	Fine, smectitic, superactive, ustic haplocryalfs
PH-6	Loamy, mixed, shallow, superactive, typic cryorthents
PH-7	Fine-loamy, mixed, superactive, ustic eutrocryepts
PH-8	Nonsoil—rock
PH-9	Fine, smectitic, ustic glossocryalfs

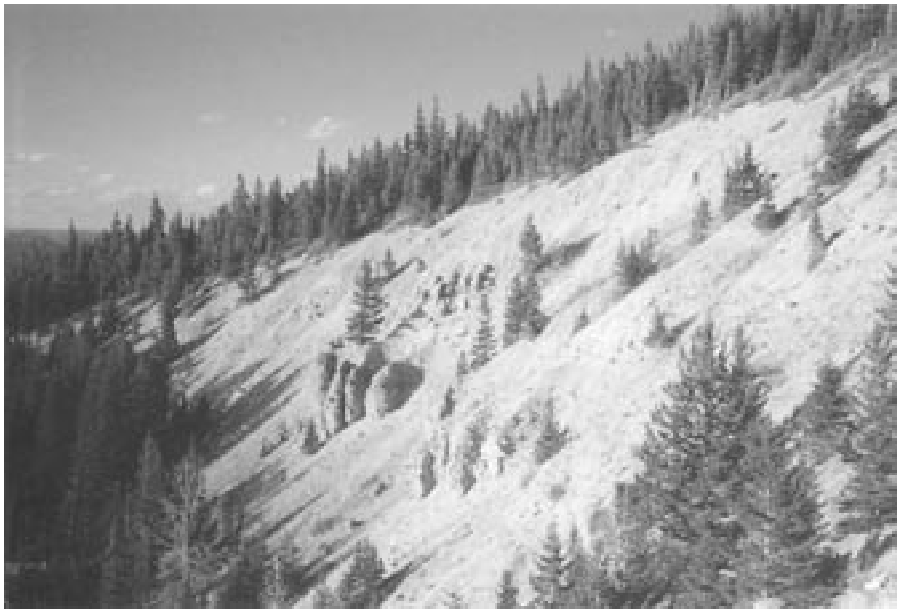


Figure 9 (*above*). North end of Saint Mary Ridge center scarp showing conglomerate outcrops.

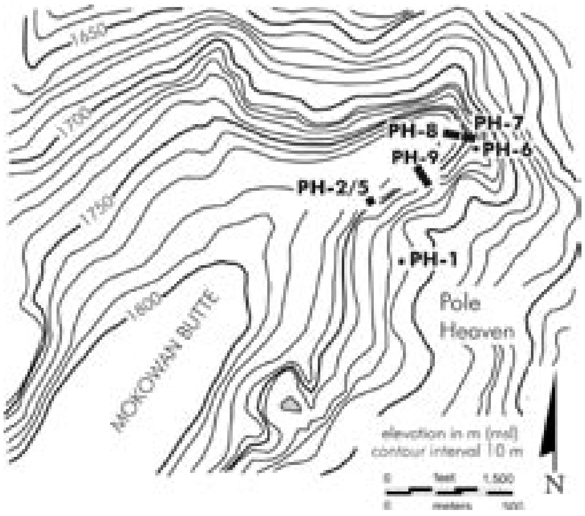


Figure 10 (*left*). Mokowan Butte Map showing Pole Heaven sample locations.

of the slope, it may be that this area was formerly stable and well vegetated.

The argillic horizon is exposed at several sites on the slope, probably due to erosion of the A horizon and exposure of the B_t horizon. This might be more difficult to establish if the entire slope were a single B_t exposure. Where present, the E horizon, a sandy loam or loam, averages about 13 cm (5 in) thick above the B_t horizon. Presence of an E horizon indicates leaching and translocation, important soil-forming mechanisms mediated by water (Klevberg and Bandy, 2003a). The argillic horizon is about 45 to 50 cm (18 to 20 in) thick above a C horizon and is a heavy clay loam to clay in texture and quite red (5YR4/6 moist). Down slope, clay films are less evident, and the slope is covered with a veneer of angular gravel (slope wash). Downslope movement creates colluvium and inhibits pedogenesis, with the A and E horizons apparently eroded off of much of the slope.

Bedrock outcrops in a road cut at PH-6 (Figure 10). It is overlain by a C horizon, then an E horizon, and between them a possible buried soil horizon. Vegetation is present, but this section may indicate past slope instability. Because the buried horizon is within the zone of current soil formation, it is not a paleosol (Klevberg et al., 2003).

The edge of Mokowan Butte at the north end of Pole Heaven (Figure 10) revealed evidence of slope instability and formation of a considerable apron of colluvium. Test pit PH-7 exposed a 6-inch (15-cm) sandy loam A horizon over an 18-inch (46-cm) B_w horizon, with an underlying C horizon of Kennedy Formation colluvium. Up slope, colluvium and conglomerate or breccia are present and soil formation is minimal. Forest vegetation and a well-developed alfisol cover Mokowan Butte at the head of this bluff.

Between PH-2 through PH-5 on the southwest, and PH-6 through PH-8 on the northeast we found what appears to be one of Karlstrom's test trenches, our PH-9, located on the main scarp face at approximately 43° to horizontal. We found a 25 cm (10 in) E horizon (loam) overlying a heavy clay loam B_t horizon overlying a B_{tk} horizon overlying rock. Clay films were relatively thick and covered pit faces, pores, and sand grains. Carbonate increased down section, forming rock at approximately 3.6 m (12 ft) vertically below the butte's rim. The rock is a carbonate-cemented, matrix-supported conglomerate with angular clasts (i.e. breccia), with colluvium below the conglomerate. In the colluvium, we found a section of argillic material that proved to be a colluvial pocket of clay-rich material, not a B_t horizon. Slope instability appeared to be a major factor in the location and exposure of argillic material, and we found no evidence of pedogenesis in the colluvial apron.

Cloudy Ridge

Only one paleosol was alleged by Karlstrom (1988; 1990; 1991; Karlstrom and Barendregt, 2001) to have been found at Cloudy Ridge, and it was supposedly exhumed. This site (Figure 1) was unlike the others we investigated, not having a concordant summit capped by Kennedy gravel. Instead, it is a pediment surface stretching from the rugged Rocky Mountains north of Waterton National Park toward the Great Plains (Figure 11). This pediment surface is considered by some to be a paleosol (Karlstrom and Barendregt, 2001; Karlstrom, 1988, 1990, 1991) and is correlated with those of Mokowan Butte, Saint Mary Ridge, Milk River Ridge, and Two Medicine Ridge. Relief at this site is less than the other sample locations visited by EGP researchers. Our CR-1 on a southeast-facing slope coincided with Karlstrom's trench (Figures 12, 13). The slope was well vegetated with small bushes and forbs except at the eroded trench. Data are presented in Table VI and slope log CR-1 (Appendix B).

Like the other sites, particularly Two Medicine Ridge, Cloudy Ridge is close to the mountain front and experiences very strong winds. The pediment surface is armored with about 80 percent coarse fragments (pebbles and cobbles), interspersed with short grass, with a rooting medium of a mollic A horizon about 8 cm (3 in) thick, atop a B_k horizon. Approximately 1.1 m (3.6 ft) vertically below the bench, an irregular, red sandy clay loam was encountered. Clay film

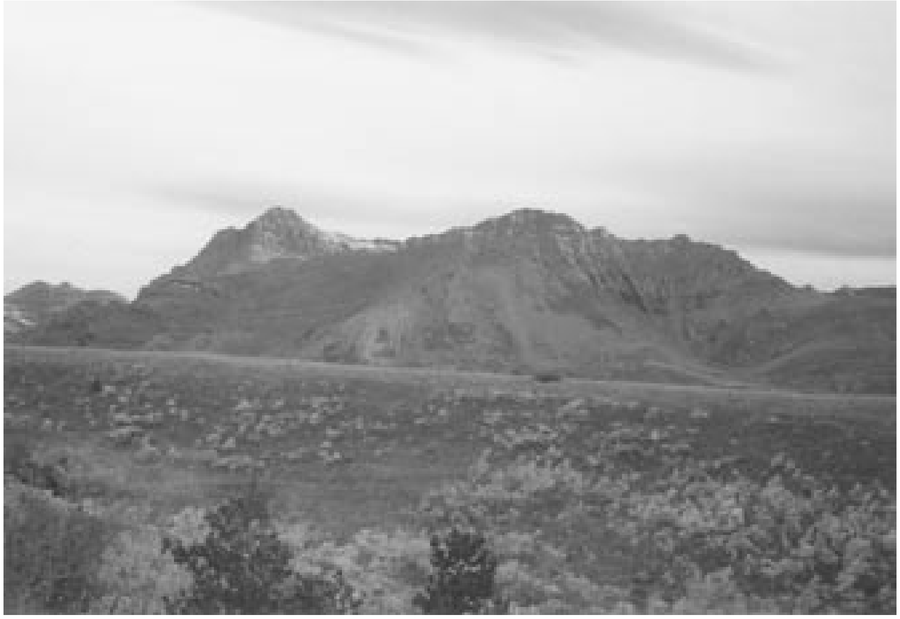


Figure 11. Photograph of Cloudy Ridge pediment surface.

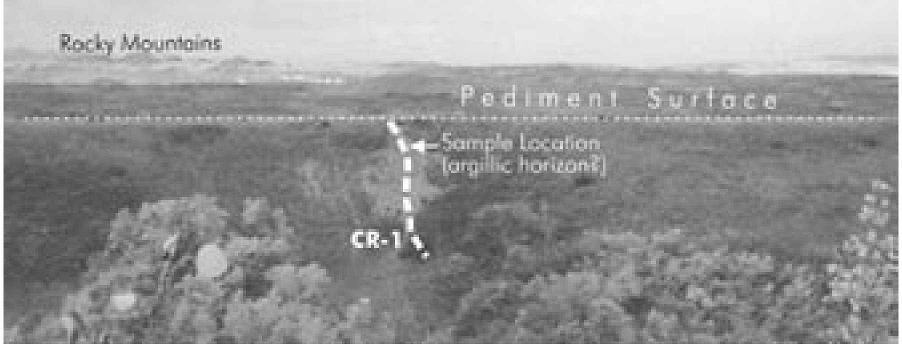


Figure 12. Cloudy Ridge Sample site photograph (trench CR-1 indicated).

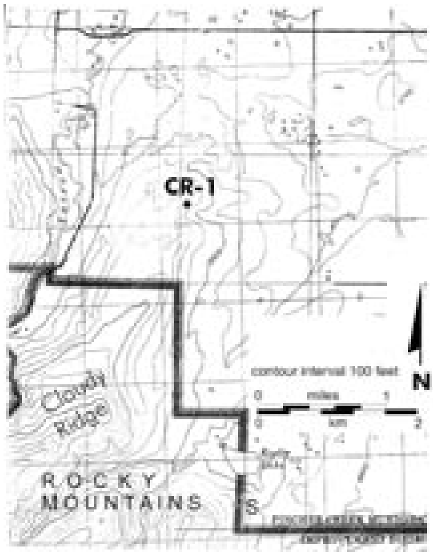


Figure 13. Cloudy Ridge Sample Map.

was present in the upper 8 cm (3 in) of soil. This may be a B_t horizon deformed by downslope movement. As at the other sites, gravel was abundant in the soil, and pebble orientation coincided with small-scale mass wasting on the unstable slope. Carbonate content was high enough to lithify the material locally, and even in lesser concentrations, it appears sufficient to stabilize other portions of the slope. A talus apron of boulders forms the toe of the slope.

Table VI. Cloudy Ridge Soils

Test Pit or Trench	Classification
CR-1 (0’)	Sandy-skeletal, mixed, typic cryorthents
CR-1 (5.5’)	Loamy-skeletal, mixed, superactive, ustic eutrocryepts
CR-1 (36’)	(not classified)
CR-1 (72’)	(not classified)

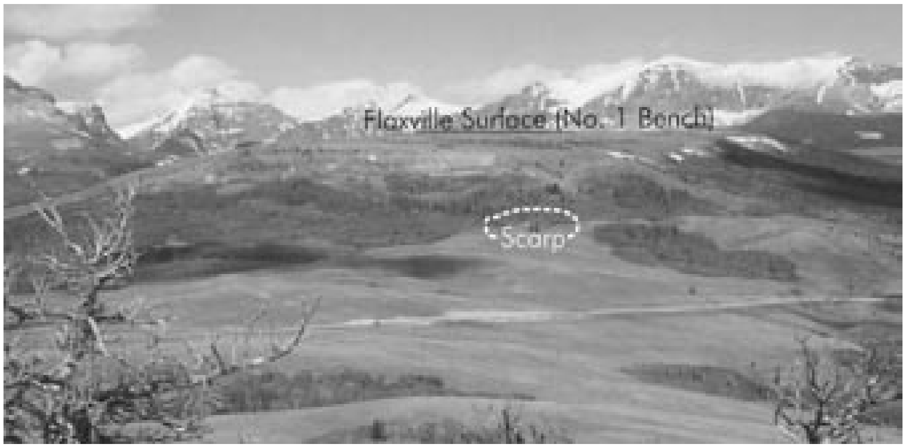


Figure 14. Cut Bank Ridge from Red Blanket Butte.

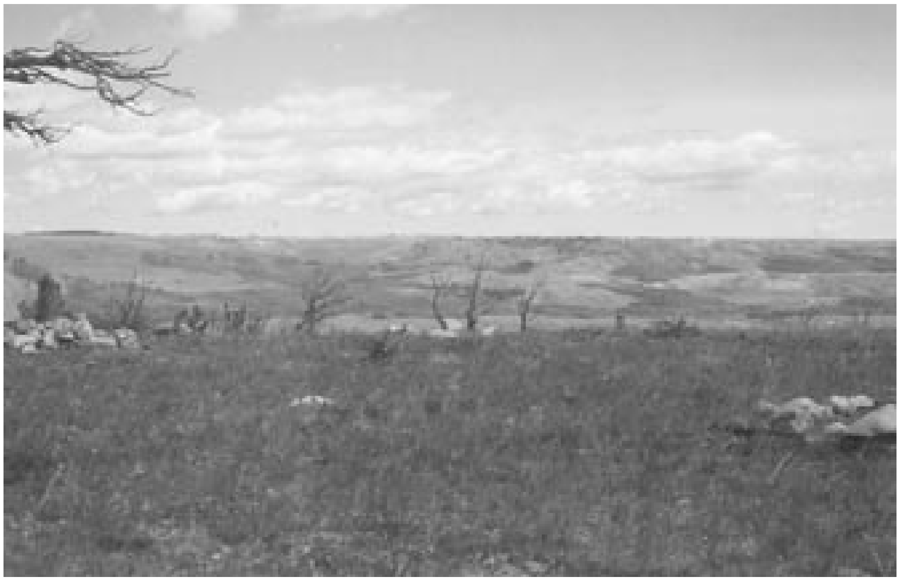


Figure 15. View from top of Red Blanket Butte toward Milk River Ridge East. Patterns of cobbles and boulders are anthropogenic.

Cut Bank Ridge

A small slump scarp was present on the east end of Cut Bank Ridge (Figure 14). Carbonate content was too low for lithification, and the entire slope is colluvial. Some vegetation has become established, but not significantly impairing erosion. However, the lack of vegetation is compensated by the highly permeable colluvium. A poorly developed A horizon was evident, but no evidence of an argillic horizon was observed.

Red Blanket Butte

Red Blanket Butte is an erosional remnant, probably the eastern continuation of Cut Bank Ridge (Figure 1). Its convex surface is like Two Medicine Ridge and Milk River Ridge, but it is lower than those larger ridges (Figure 15). It may have originally been a slight depression in the Flaxville surface that led to development of the drainages forming the North and South Forks of Cut Bank Creek (Figure 1). We found no prominent scarps on Red Blanket Butte, and the presence of culturally important anthropogenic features (graves, teepee rings) precluded excavation or other disturbance of the site. Material visible on the surface appeared to be Kennedy gravel with some notable dolostone boulders. No igneous lithologies were observed. Some large, angular boulders or blocks may have been a weathered outcrop of limestone; if so, the Kennedy Formation is very thin atop Red Blanket Butte. Soils appear to be generally alfisols, and the ground surface is covered with grass except for the north slope, which is forested with *Pinus contorta latifolia* and *Pseudotsuga* *menzesii*, with scattered trees elsewhere on the butte.

Milk River Ridge (East)

The east half of Milk River Ridge appeared to resemble the west part, but lacked the unvegetated landslide scarp noted in Karlstrom's previous investigations there. Kennedy gravel was observed on the slopes of the east part of Milk River Ridge, but most of this was slope wash over sandstone bedrock. The deposit is thicker over the center part of the ridge. Igneous boulders are rounded, as are many of the Belt clasts. A few argillite clasts exhibited striations. Deposits farther east on this ridge are not mapped as Kennedy Formation (Cannon, 1996), but the contact between these formations appears to be gradational. The slope east-northeast along the ridge crest is about four percent (2¼°). The ridge is covered with thick grass, and slopes are forested (Figure 16). No scarps were observed, but road cuts and small coulees (draws) provided some opportunity to observe soils, which appeared to be alfisols similar to TM-1 and TM-4.

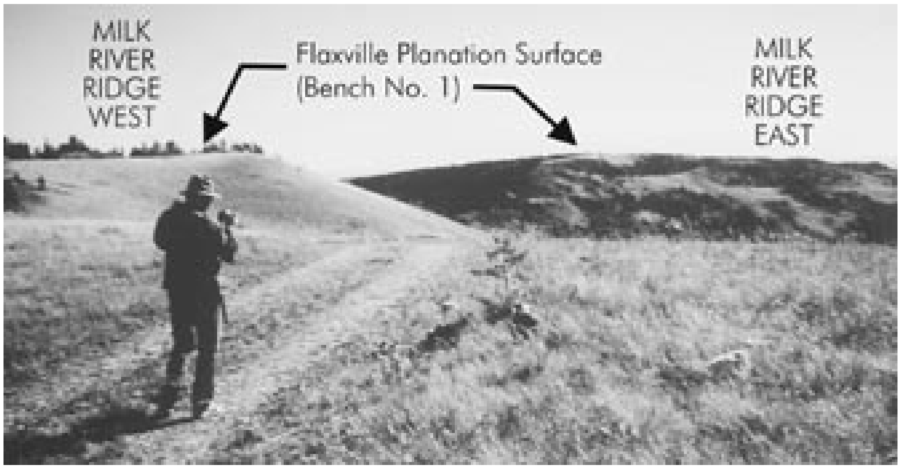


Figure 16. East end of Milk River Ridge from west end of ridge.

Swiftcurrent Ridge

The eroded top of Swiftcurrent Ridge slopes gently to the northeast and is capped by Kennedy gravel, which ap-

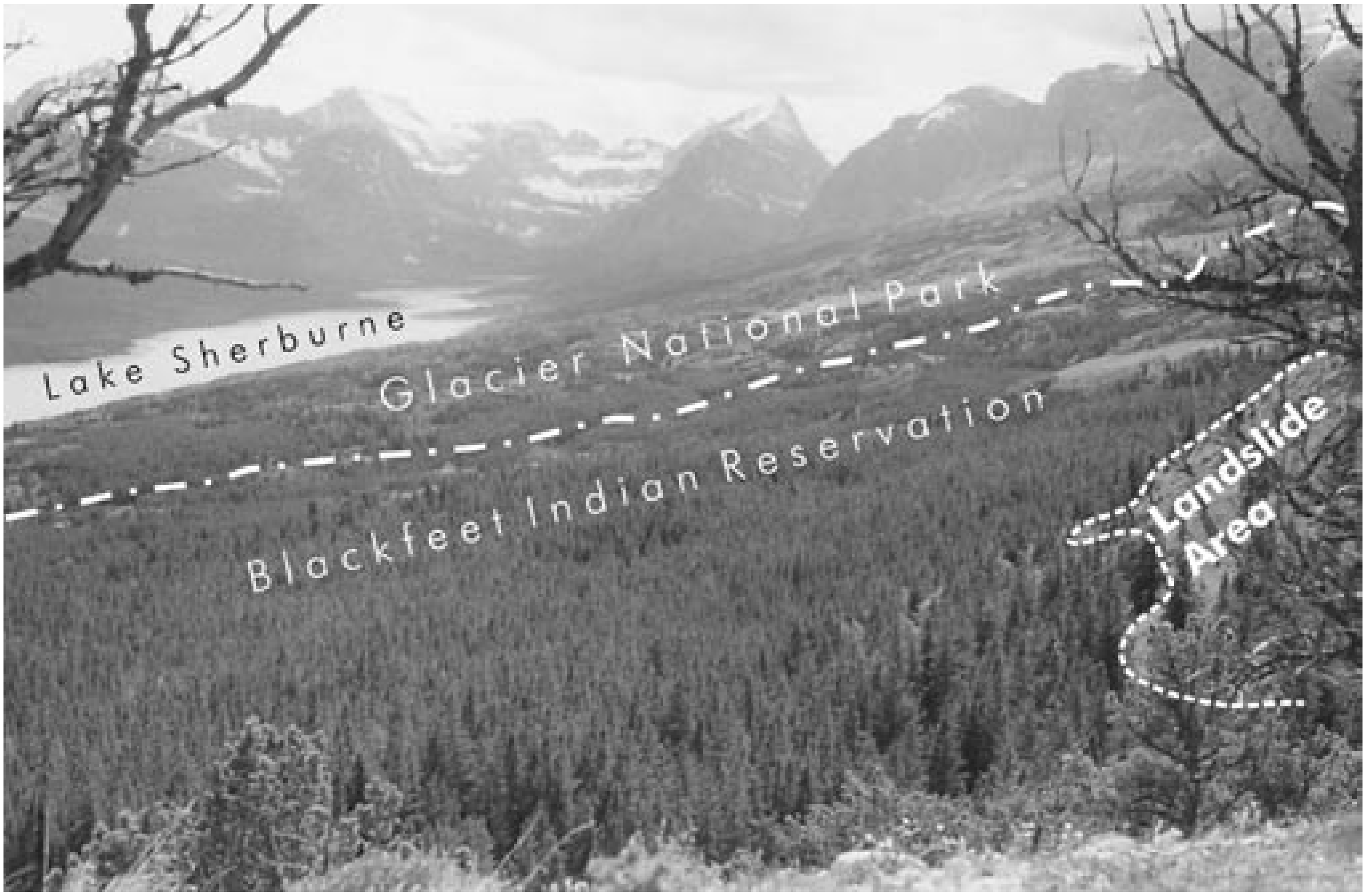


Figure 17. View west along south side of Swiftcurrent Ridge showing landslide area.

pears slightly more rounded than on Two Medicine and Saint Mary Ridges and contains cataclastic dolostone and some mafic lithologies. Relatively good soil development has occurred in the Kennedy Formation; the ridge top is well vegetated with grasses, and the slopes forested. A slump on the south side (Figure 17) exposes the Kennedy Formation, and a sandy gravel colluvium that would classify as an entisol. Elsewhere in the site vicinity, soils appeared to be alfisols. The soil on top of the ridge consists of a dark brown loam A horizon 8 cm (3 in) thick above a sandy loam E horizon with much gravel. In the slump scarp, a reddish brown argillic horizon penetrated by roots was present beneath the E horizon. Elsewhere, the slope was mantled with colluvium. Only occasionally is carbonate abundant enough to form small amounts of conglomerate.

Summary

Deposits interpreted by EGP researchers as paleosols are found in the Kennedy Formation, which is interpreted as glacial (Klevberg and Oard, 2005). Landslide scarps generally show continued slope instability. Soils observed on stable slopes were generally alfisols (Klevberg and Bandy, 2003a), characteristic of well-drained forest cover. Unstable slopes were generally mantled with entisols.

Appendix A: Research Methods

Our goal was to obtain adequate geologic and pedologic data to judge between competing natural history hypotheses. We examined sites previously published by EGP researchers as a minimum for this investigation. The majority of the sites are on the Blackfeet Indian Reservation (Figure 1), and permission for our research was graciously granted by the Blackfeet Nation. Isolated outcrops of Kennedy Formation occur inside Glacier National Park. These were observed but not sampled. Canadian residents assisted us in gaining access to sites north of the border.

Investigation of published "paleosol" trenches was essential to understand both field conditions and data used by EGP researchers. We reopened these trenches by removing loose material from their surfaces and digging shallow test pits within them to examine "intact" earth materials (Figure 6). Measured distances along each trench identified field description and laboratory sample locations (Figure 18). Slope gradients were measured with a Brunton compass to convert long-slope distances to elevations for sample log preparation and comparison with published information. To permit careful examination of earth materials and measurement along unstable slopes, we rappelled down some of the landslide scarps, especially those proximate to conglomerate outcrops (Figure 19).

We excavated additional test pits proximate to most of the original test trenches (Figure 20) to better ascertain lateral facies changes and ongoing pedogenesis. Test pits were also excavated away from unstable slopes to better evaluate local soil formation conditions. Laboratory analysis compared samples

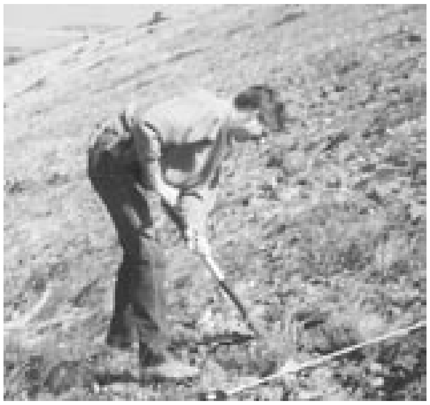


Figure 18. Excavation of trench TM-2, steel tape used for long-slope measurement.

Figure 19. Rappelling permitted convenient and careful examination of outcrops.

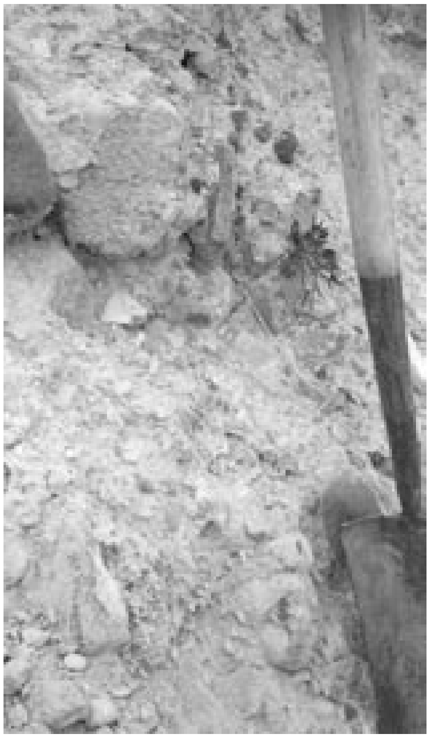


Figure 20. A spade was used to hand excavate in and along previous test trenches (SM-4).

Figure 21. Field examination of test pit TM-1.

from stable and unstable slopes.

Other scarps exposing Kennedy Formation were observed to test stratigraphic interpretations and evidence for or against modern soil formation. Observation was limited to scarp surfaces and test pits; no trenches of the kind used by previous researchers were excavated, out of respect for tribal land and to minimize erosion. In addition to the creation of test pit and slope logs (presented in Part II of this series) and evaluation of laboratory data, we examined soil maps of the Blackfeet Indian Reservation sites available at the Natural Resources Conservation Service office of the U.S. Department of Agriculture.

Soil descriptions were based on standard practices (Figure 21) and used USDA nomenclature (Soil Survey Division Staff 1993; 1999). Colors are based on a Munsell color chart and are moist colors unless displayed in parentheses. To the extent feasible, soil samples were collected by excavating around the material to be collected and molding a piece of aluminum foil around it, marking the foil with a north arrow and top marking, and placing it in a sealed plastic bag. Noncohesive soils were sometimes too friable to collect oriented or "undisturbed" samples, though the same methods were used. Thin section, petrologic, and electron microscopy results were provided as high-resolution color images. Thin section images included plane polarized and cross-polarized pairs, and reflected light images, all at 400x magnification. Scanning electron microscopy (SEM) and scanning electron microscopy backscatter electron imaging (SEMBSE) were also performed. Geologic descriptions were based on field examination of gravel veneers, float, test trenches and pits, outcrops, and textural classification of unconsolidated materials using the Unified Soil Classification System (ASTM, 1992). Attitudes of clasts and larger features were measured using a Brunton compass. No additional laboratory data (e.g. sesquioxide content, physil species) were obtained. We had no reason to doubt their quality as published, nor did we think that additional chemical data would be essential in evaluating alternative natural history scenarios, since interpretation of these data is equivocal (Klevberg and Bandy, 2003b).

In addition to outcrop-scale investigation, we observed geomorphology and topography. Topography is particularly important in identifying true paleosols. Site orientation has a profound effect on the microclimate and thus vegetation, which in turn are significant factors in soil formation (Klevberg and Bandy, 2003a).

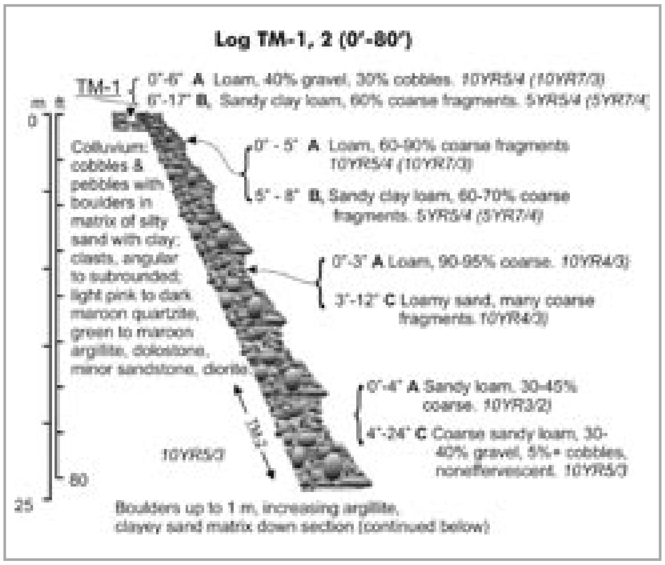
Appendix B: Slope Logs

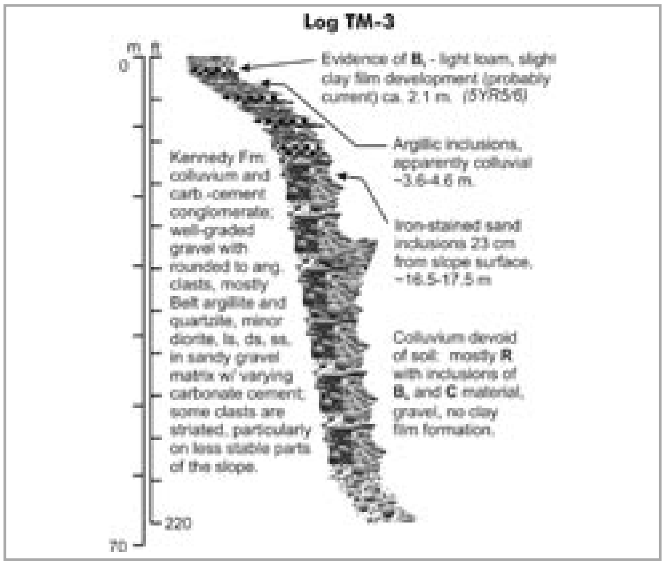
Slope log legend:

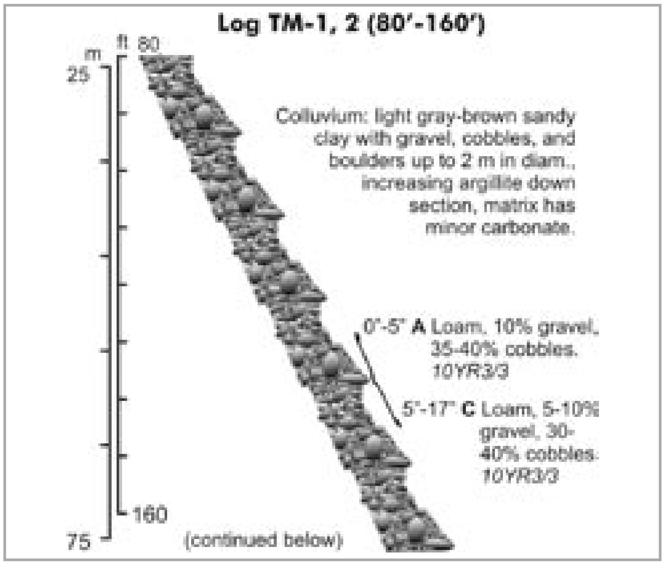
▤	Stony Loam: primarily angular clasts in loamy matrix
▨	Colluvium: gravel with clay-dominated matrix, may contain carbonate
▨	Colluvium: predominantly argillite gravel with sandy matrix, may contain carbonate
▨	Colluvium: gravel with matrix dominated by carbonate; may be locally cemented to conglomerate
▨	Colluvium: gravel with loose matrix or clast support, typically coarse slope toe deposits
▨	Conglomerate: predominantly argillite gravel supported by sand matrix cemented by calcite

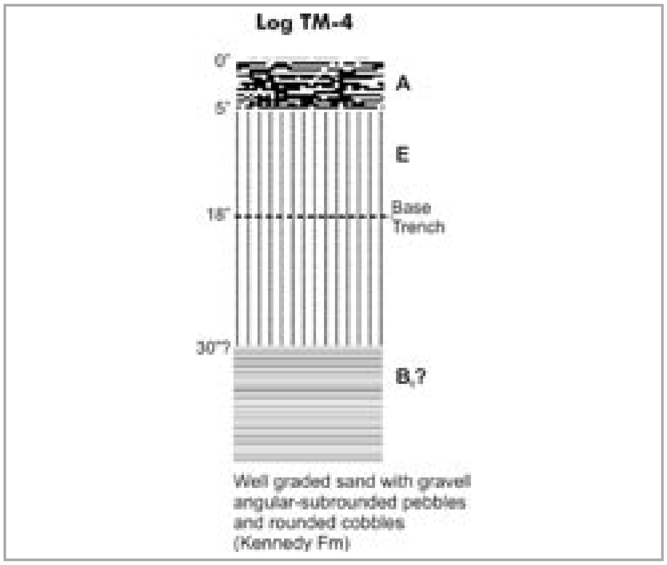
Trench log legend:

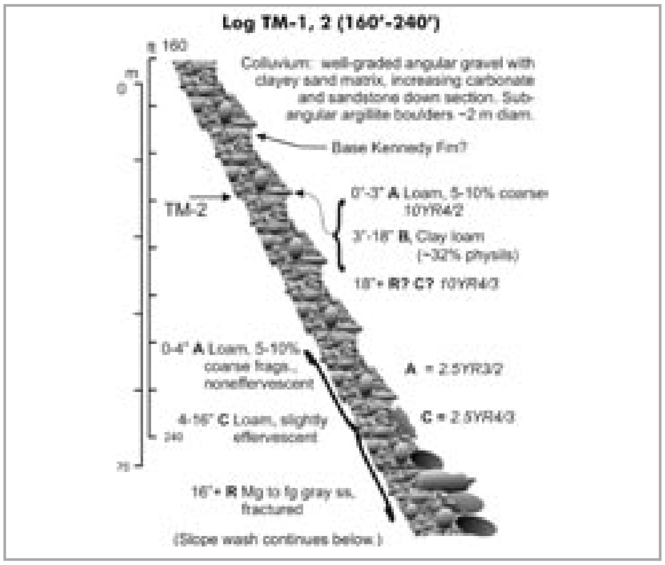
▩	Organic horizor
▥	Sandy loam or E horizon
▤	Clay loam, B, or argillic horizon

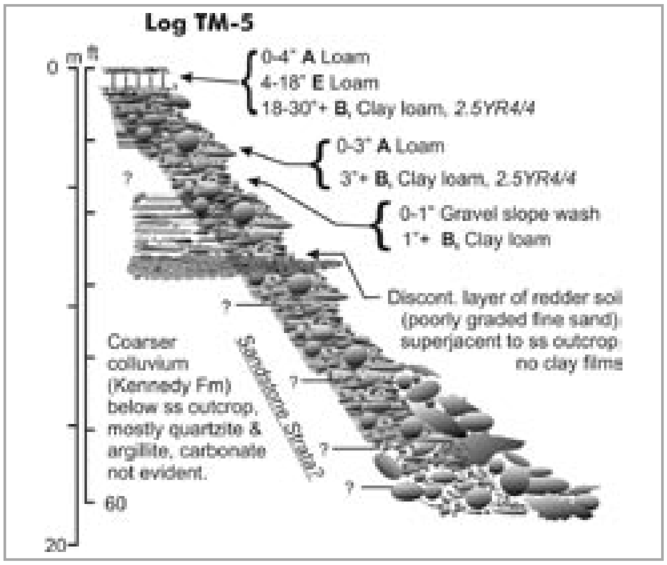

Log TM-1, 2 (0'-80')
TM-1
0"-6" A Loam, 40% gravel, 30% cobbles. 10YR5/4 (10YR7/3)
6"-17" Bt Sandy clay loam, 60% coarse fragments. 5YR5/4 (5YR7/4)
m ft
0
Colluvium: cobbles & pebbles with boulders in matrix of silty sand with clay; clasts, angular to subrounded; light pink to dark maroon quartzite, green to maroon argillite, dolostone, minor sandstone, diorite
0" - 5" A Loam, 60-90% coarse fragments 10YR5/4 (10YR7/3)
5" - 8" Bt Sandy clay loam, 60-70% coarse fragments. 5YR5/4 (5YR7/4)
0"-3" A Loam, 90-95% coarse. 10YR4/3)
3"-12" C Loamy sand, many coarse fragments. 10YR4/3)
0"-4" A Sandy loam, 30-45% coarse. 10YR3/2)
4"-24" C Coarse sandy loam, 30-40% gravel, 5%+ cobbles, noneffervescent. 10YR5/3
TM-2
10YR5/3
80
25
Boulders up to 1 m, increasing argillite, clayey sand matrix down section (continued below)

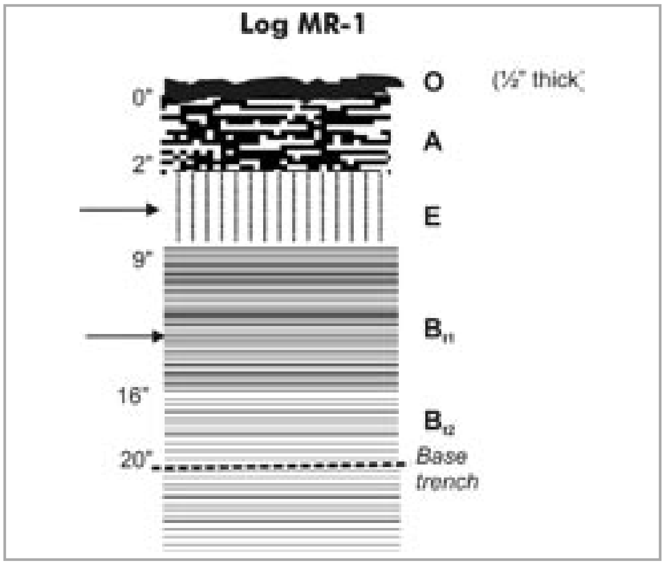

Log TM-3
m ft
0
Evidence of Bt - light loam, slight clay film development (probably current) ca. 2.1 m. (5YR5/6)
Argillic inclusions, apparently colluvial ~3.6-4.6 m.
Kennedy Fm: colluvium and carb.-cement conglomerate; well-graded gravel with rounded to ang. clasts, mostly Belt argillite and quartzite, minor diorite, ls, ds, ss, in sandy gravel matrix w/ varying carbonate cement; some clasts are striated, particularly on less stable parts of the slope.
Iron-stained sand inclusions 23 cm from slope surface, ~16.5-17.5 m
Colluvium devoid of soil: mostly R with inclusions of Bt and C material, gravel, no clay film formation.
220
70

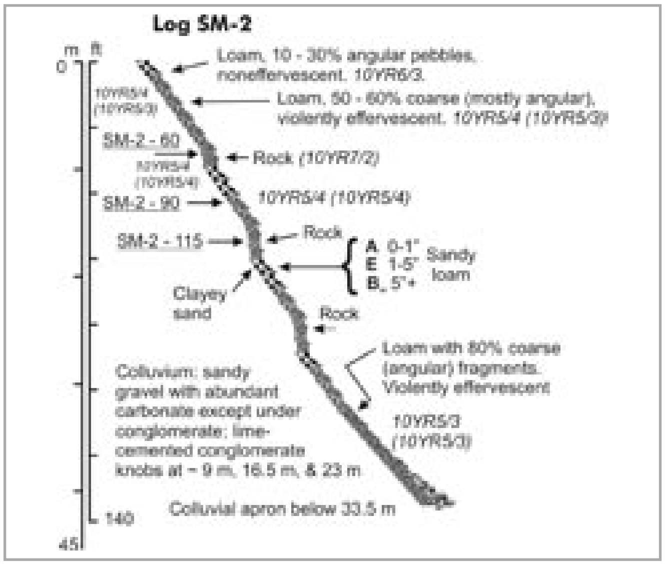

Log TM-1, 2 (80'-160')
m ft 80
25
Colluvium: light gray-brown sandy clay with gravel, cobbles, and boulders up to 2 m in diam., increasing argillite down section, matrix has minor carbonate.
0"-5" A Loam, 10% gravel, 35-40% cobbles. 10YR3/3
5"-17" C Loam, 5-10% gravel, 30-40% cobbles. 10YR3/3
160
75
(continued below)

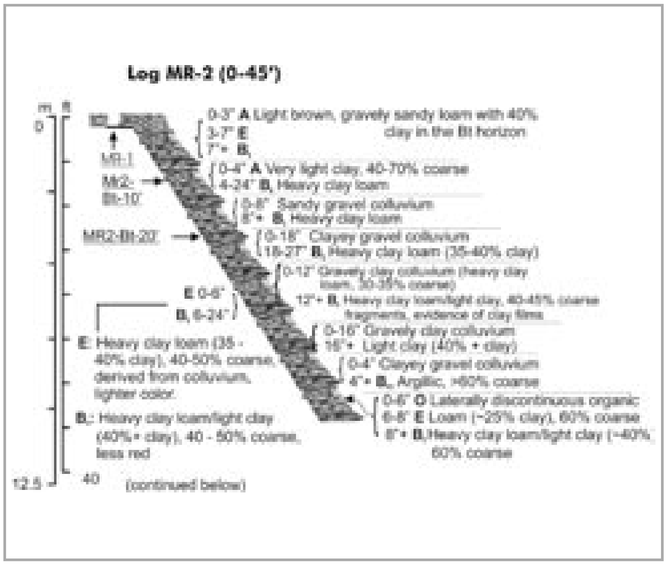

Log TM-4
0"
A
5"
E
18"
Base Trench
30"?
Bt?
Well graded sand with gravell angular-subrounded pebbles and rounded cobbles (Kennedy Fm)

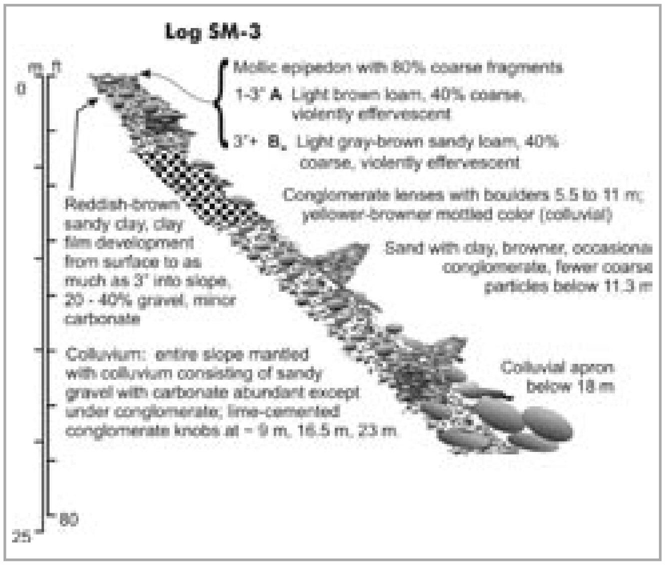

Log TM-1, 2 (160'-240')
ft 160
m
0
Colluvium: well-graded angular gravel with clayey sand matrix, increasing carbonate and sandstone down section. Sub-angular argillite boulders ~2 m diam.
Base Kennedy Fm?
TM-2
0"-3" A Loam, 5-10% coarse 10YR4/2
3"-18" Bt Clay loam (~32% physils)
18"+ R? C? 10YR4/3
0-4" A Loam, 5-10% coarse frags., noneffervescent
A = 2.5YR3/2
4-16" C Loam, slightly effervescent
C = 2.5YR4/3
240
75
16"+ R Mg to fg gray ss, fractured
(Slope wash continues below.)

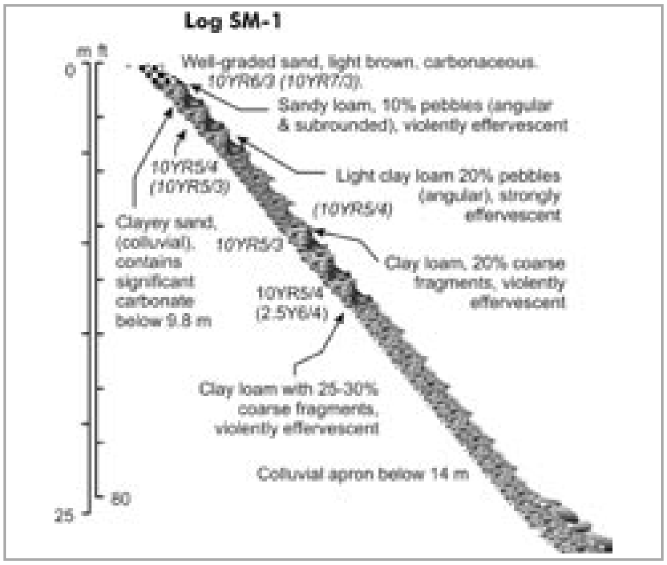

Log TM-5
m ft
0
0-4" A Loam
4-18" E Loam
18-30"+ Bt Clay loam, 2.5YR4/4
0-3" A Loam
3"+ Bt Clay loam, 2.5YR4/4
?
0-1" Gravel slope wash
1"+ Bt Clay loam
Discont. layer of redder soil (poorly graded fine sand); superjacent to ss outcrop; no clay films
?
Coarser colluvium (Kennedy Fm) below ss outcrop, mostly quartzite & argillite, carbonate not evident.
Sandstone Strata?
?
?
?
60
20

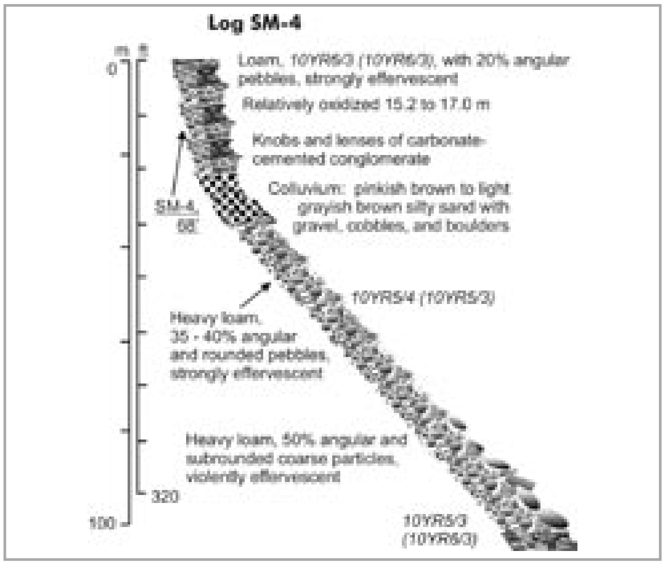

Log MR-1
0"
2"
9"
16"
20"
O
(½" thick)
A
E
B_t1
B_t2
Base trench

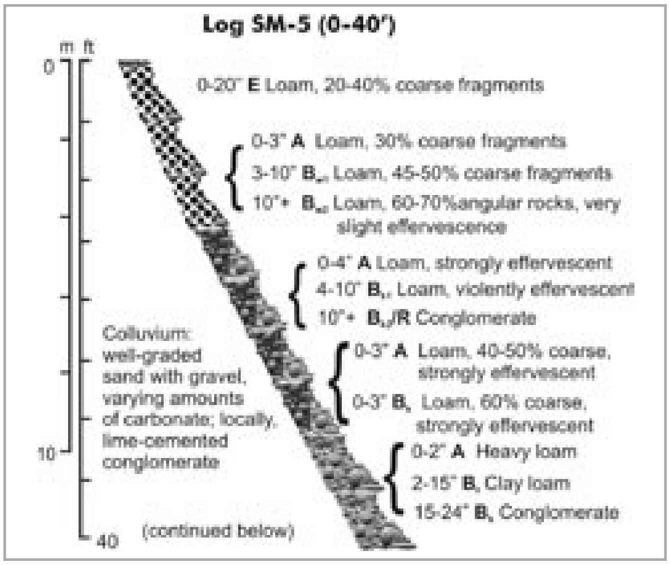

Log SM-2
m ft
0
Loam, 10 - 30% angular pebbles, noneffervescent. 10YR6/3.
10YR5/4 (10YR5/3)
Loam, 50 - 60% coarse (mostly angular), violently effervescent. 10YR5/4 (10YR5/3)
SM-2 - 60
Rock (10YR7/2)
10YR5/4 (10YR5/4)
SM-2 - 90
10YR5/4 (10YR5/4)
SM-2 - 115
Rock
A 0-1"
E 1-5"
B_t 5"+
Sandy loam
Clayey sand
Rock
Loam with 80% coarse (angular) fragments. Violently effervescent
Colluvium: sandy gravel with abundant carbonate except under conglomerate; lime-cemented conglomerate knobs at ~ 9 m, 16.5 m, & 23 m
10YR5/3 (10YR5/3)
Colluvial apron below 33.5 m
140
45

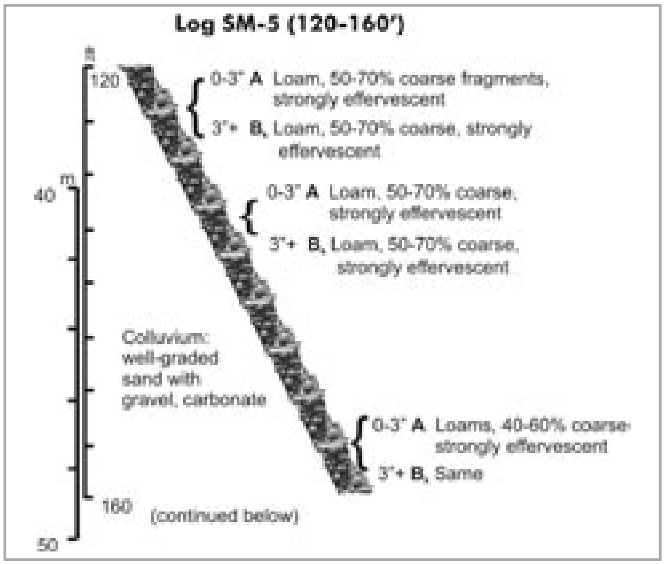

Log MR-2 (0-45')
m ft
0
MR-1
Mr2-Bt-10'
MR2-Bt-20'
0-3" A Light brown, gravely sandy loam with 40% clay in the Bt horizon
3-7" E
7"+ B_t
0-4" A Very light clay, 40-70% coarse
4-24" B_t Heavy clay loam
0-8" Sandy gravel colluvium
8"+ B_t Heavy clay loam
0-18" Clayey gravel colluvium
18-27" B_t Heavy clay loam (35-40% clay)
0-12" Gravelly clay colluvium (heavy clay loam, 30-35% coarse)
12"+ B_t Heavy clay loam/light clay, 40-45% coarse fragments, evidence of clay films
E 0-6"
B_t 6-24"
E: Heavy clay loam (35 - 40% clay), 40-50% coarse, derived from colluvium, lighter color.
B_t: Heavy clay loam/light clay (40%+ clay), 40 - 50% coarse, less red
0-16" Gravelly clay colluvium
16"+ Light clay (40% + clay)
0-4" Clayey gravel colluvium
4"+ B_t Argillic, >60% coarse
0-6" O Laterally discontinuous organic
6-8" E Loam (~25% clay), 60% coarse
8"+ B_t Heavy clay loam/light clay (~40% 60% coarse
12.5
40
(continued below)

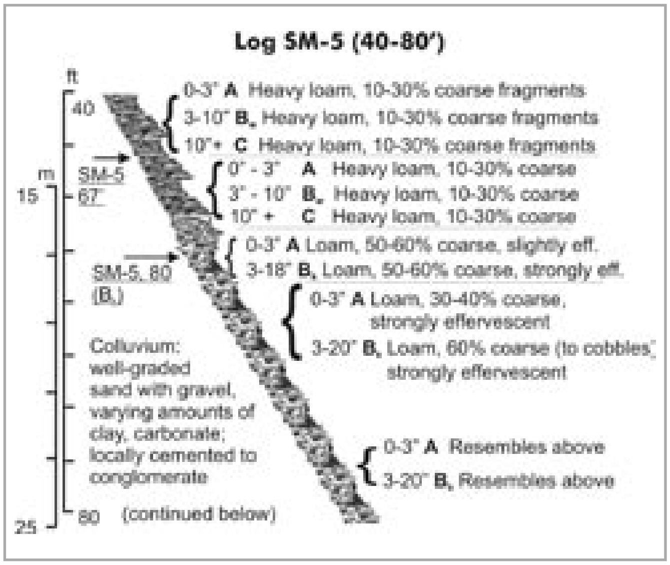

Log SM-3
m ft
0
Mollic epipedon with 80% coarse fragments
1-3" A Light brown loam, 40% coarse, violently effervescent
3"+ B_k Light gray-brown sandy loam, 40% coarse, violently effervescent
Conglomerate lenses with boulders 5.5 to 11 m; yellower-browner mottled color (colluvial)
Reddish-brown sandy clay, clay film development from surface to as much as 3" into slope, 20 - 40% gravel, minor carbonate
Sand with clay, browner, occasional conglomerate, fewer coarse particles below 11.3 m
Colluvium: entire slope mantled with colluvium consisting of sandy gravel with carbonate abundant except under conglomerate; lime-cemented conglomerate knobs at ~ 9 m, 16.5 m, 23 m.
Colluvial apron below 18 m
80
25

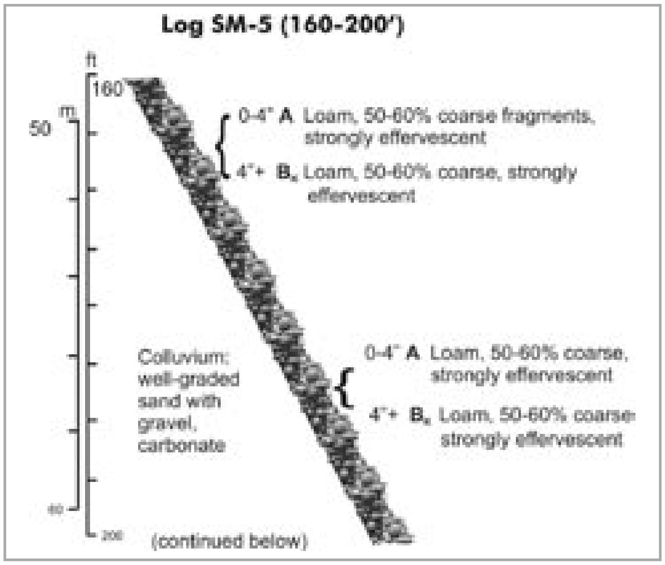

Log SM-1
m ft
0
Well-graded sand, light brown, carbonaceous. 10YR6/3 (10YR7/3).
Sandy loam, 10% pebbles (angular & subrounded), violently effervescent
10YR5/4 (10YR5/3)
Light clay loam 20% pebbles (angular), strongly effervescent
(10YR5/4)
Clayey sand, (colluvial), contains significant carbonate below 9.8 m
10YR5/3
Clay loam, 20% coarse fragments, violently effervescent
10YR5/4 (2.5Y6/4)
Clay loam with 25-30% coarse fragments, violently effervescent
Colluvial apron below 14 m
80
25

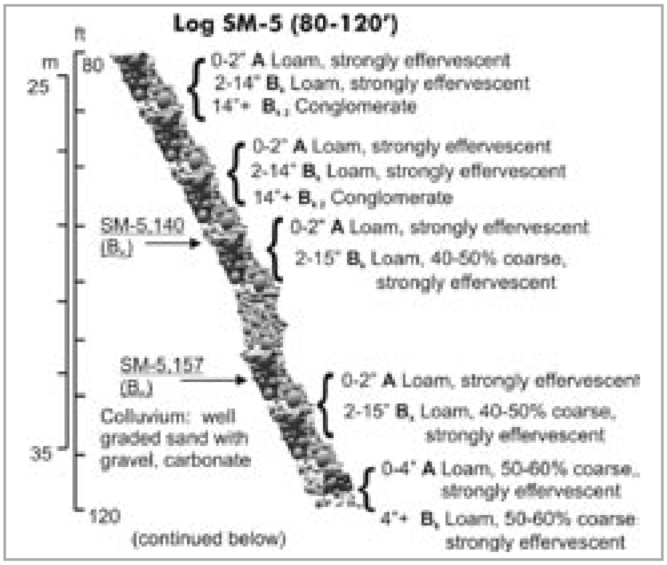

Log SM-4
m ft
0
Loam, 10YR6/3 (10YR6/3), with 20% angular pebbles, strongly effervescent
Relatively oxidized 15.2 to 17.0 m
Knobs and lenses of carbonate-cemented conglomerate
Colluvium: pinkish brown to light grayish brown silty sand with gravel, cobbles, and boulders
SM-4, 68'
10YR5/4 (10YR5/3)
Heavy loam, 35 - 40% angular and rounded pebbles, strongly effervescent
Heavy loam, 50% angular and subrounded coarse particles, violently effervescent
320
100
10YR5/3 (10YR6/3)

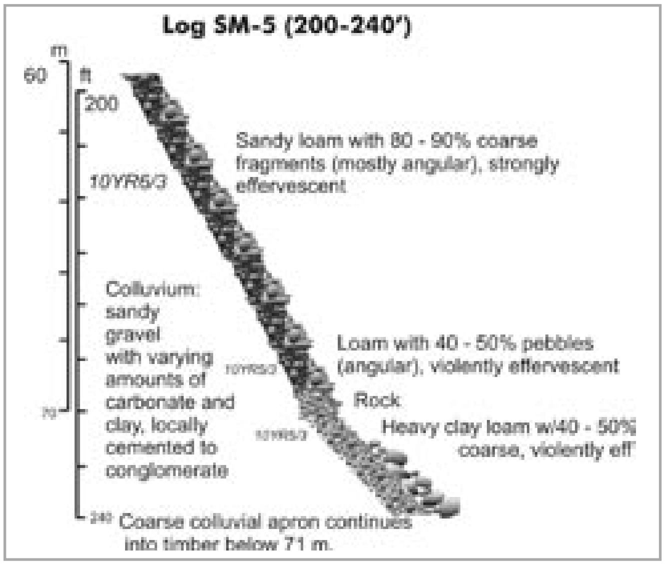

Log SM-5 (0-40′)
m ft
0
10
40
0-20" E Loam, 20-40% coarse fragments
0-3" A Loam, 30% coarse fragments
3-10" Bw1 Loam, 45-50% coarse fragments
10"+ Bw2 Loam, 60-70%angular rocks, very slight effervescence
0-4" A Loam, strongly effervescent
4-10" Bk1 Loam, violently effervescent
10"+ Bk2/R Conglomerate
0-3" A Loam, 40-50% coarse, strongly effervescent
0-3" Bk Loam, 60% coarse, strongly effervescent
0-2" A Heavy loam
2-15" Bt Clay loam
15-24" Bk Conglomerate
Colluvium: well-graded sand with gravel, varying amounts of carbonate; locally, lime-cemented conglomerate
(continued below)

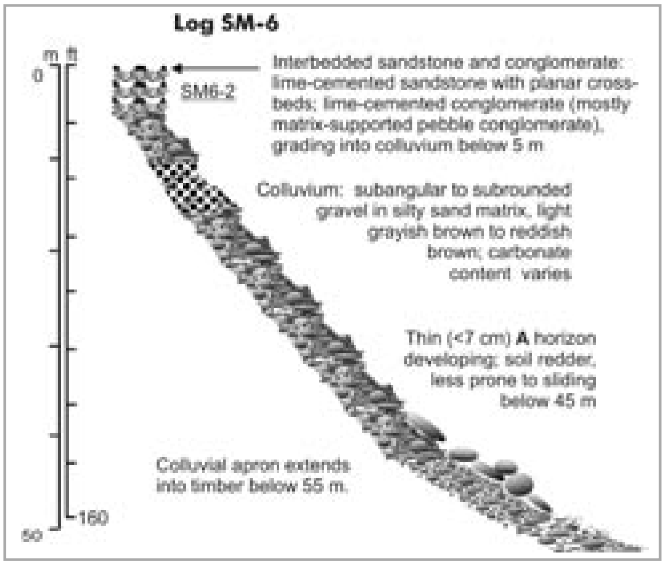

Log SM-5 (120-160′)
ft
120
m
40
160
50
0-3" A Loam, 50-70% coarse fragments, strongly effervescent
3"+ Bk Loam, 50-70% coarse, strongly effervescent
0-3" A Loam, 50-70% coarse, strongly effervescent
3"+ Bk Loam, 50-70% coarse, strongly effervescent
Colluvium: well-graded sand with gravel, carbonate
0-3" A Loams, 40-60% coarse strongly effervescent
3"+ Bk Same
(continued below)

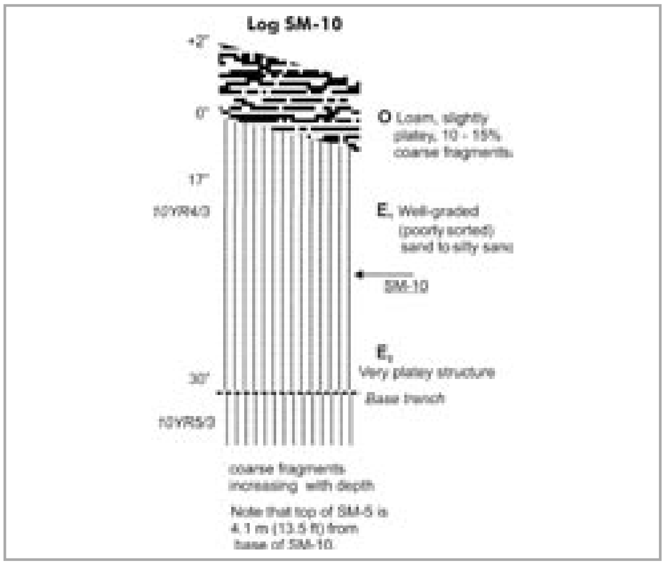

Log SM-5 (40-80′)
ft
40
m
15
25
80
0-3" A Heavy loam, 10-30% coarse fragments
3-10" Bw Heavy loam, 10-30% coarse fragments
10"+ C Heavy loam, 10-30% coarse fragments
SM-5 67"
0" - 3" A Heavy loam, 10-30% coarse
3" - 10" Bw Heavy loam, 10-30% coarse
10" + C Heavy loam, 10-30% coarse
0-3" A Loam, 50-60% coarse, slightly eff.
3-18" Bk Loam, 50-60% coarse, strongly eff.
SM-5, 80 (Bk)
0-3" A Loam, 30-40% coarse, strongly effervescent
3-20" Bk Loam, 60% coarse (to cobbles; strongly effervescent
Colluvium: well-graded sand with gravel, varying amounts of clay, carbonate; locally cemented to conglomerate
0-3" A Resembles above
3-20" Bk Resembles above
(continued below)

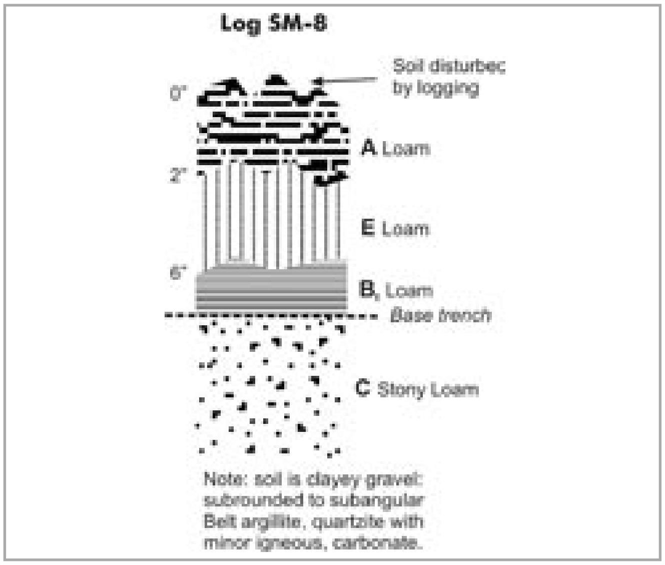

Log SM-5 (160-200′)
ft
160
m
50
60
200
0-4" A Loam, 50-60% coarse fragments, strongly effervescent
4"+ Bk Loam, 50-60% coarse, strongly effervescent
Colluvium: well-graded sand with gravel, carbonate
0-4" A Loam, 50-60% coarse, strongly effervescent
4"+ Bk Loam, 50-60% coarse strongly effervescent
(continued below)

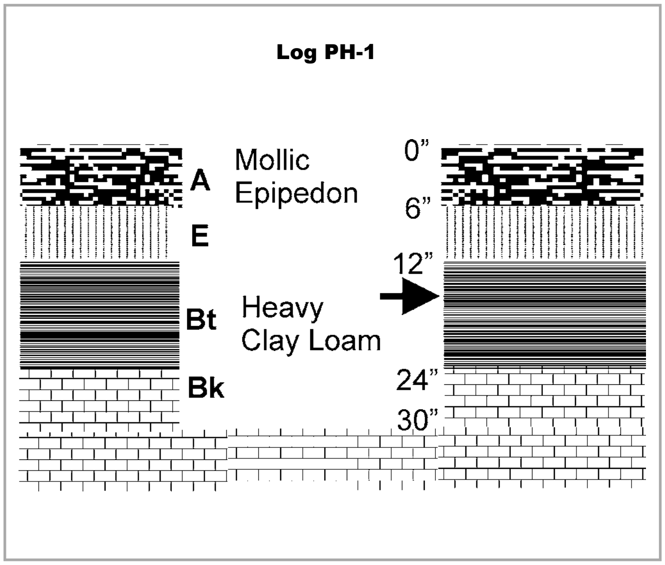

Log SM-5 (80-120′)
ft
m
80
25
35
120
0-2" A Loam, strongly effervescent
2-14" Bk Loam, strongly effervescent
14"+ Bk2 Conglomerate
0-2" A Loam, strongly effervescent
2-14" Bk Loam, strongly effervescent
14"+ Bk2 Conglomerate
SM-5,140 (Bk)
0-2" A Loam, strongly effervescent
2-15" Bk Loam, 40-50% coarse, strongly effervescent
SM-5,157 (Bk)
0-2" A Loam, strongly effervescent
2-15" Bk Loam, 40-50% coarse, strongly effervescent
Colluvium: well graded sand with gravel, carbonate
0-4" A Loam, 50-60% coarse., strongly effervescent
4"+ Bk Loam, 50-60% coarse strongly effervescent
(continued below)

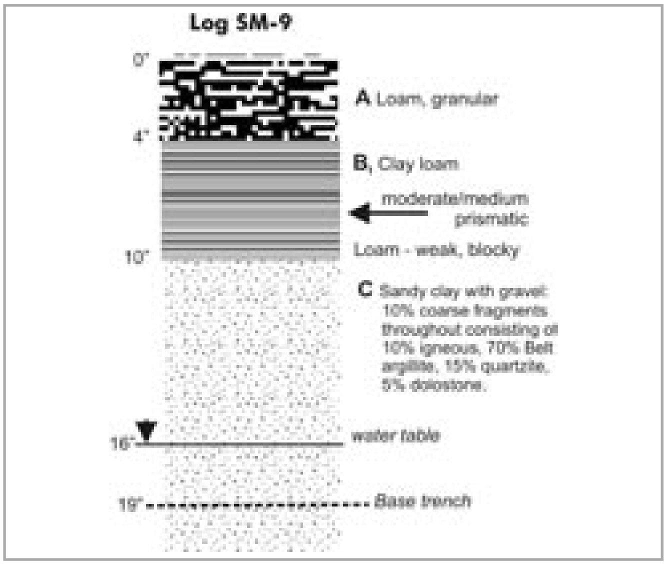

Log SM-5 (200-240′)
m
60
ft
200
70
240
10YR5/3
Sandy loam with 80 - 90% coarse fragments (mostly angular), strongly effervescent
Colluvium: sandy gravel with varying amounts of carbonate and clay, locally cemented to conglomerate
10YR5/3
Loam with 40 - 50% pebbles (angular), violently effervescent
Rock
10YR5/3
Heavy clay loam w/40 - 50% coarse, violently eff
Coarse colluvial apron continues into timber below 71 m.

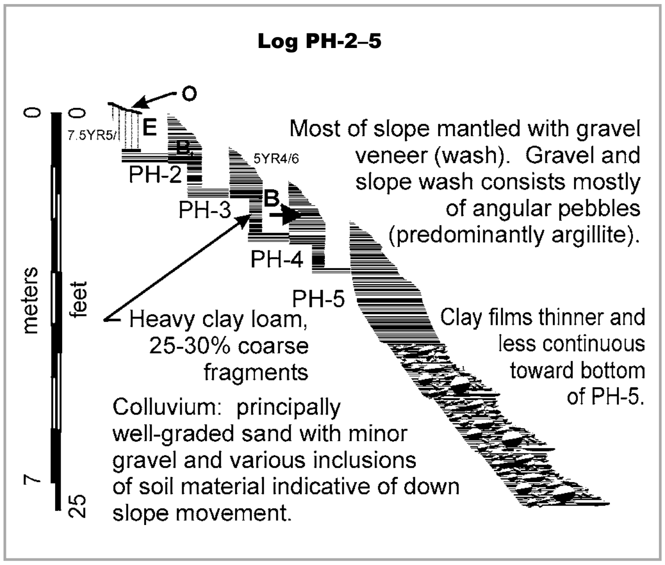

Log SM-6
m ft
0
SM6-2
Interbedded sandstone and conglomerate: lime-cemented sandstone with planar cross-beds; lime-cemented conglomerate (mostly matrix-supported pebble conglomerate), grading into colluvium below 5 m
Colluvium: subangular to subrounded gravel in silty sand matrix, light grayish brown to reddish brown; carbonate content varies
Thin (<7 cm) A horizon developing; soil redder, less prone to sliding below 45 m
Colluvial apron extends into timber below 55 m.
160
50

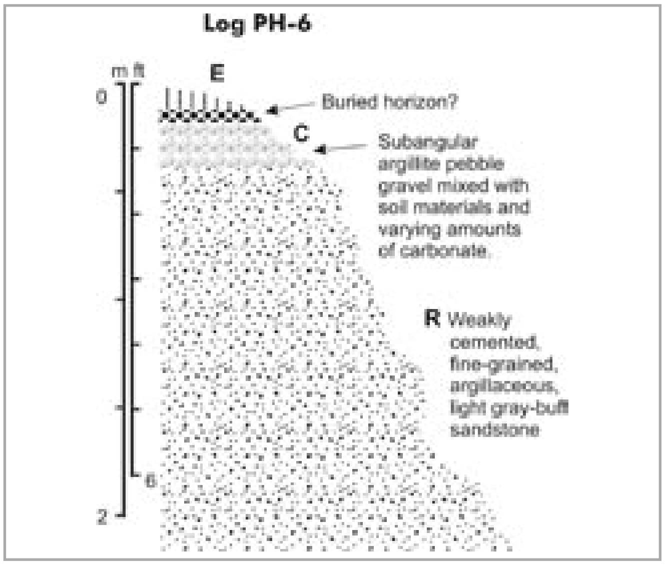

Log SM-10
+2"
0"
O Loam, slightly platey, 10 - 15% coarse fragments
17"
10YR4/3
E Well-graded (poorly sorted) sand to silty sand
SM-10
E
Very platey structure
30"
Base trench
10YR5/3
coarse fragments increasing with depth
Note that top of SM-5 is 4.1 m (13.5 ft) from base of SM-10.

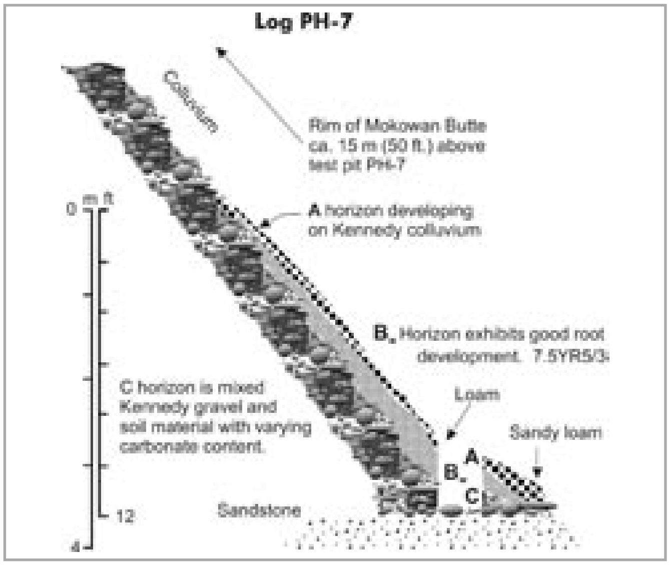

Log SM-8
Soil disturbec by logging
0"
A Loam
2"
E Loam
6"
B_t Loam
Base trench
C Stony Loam
Note: soil is clayey gravel: subrounded to subangular Belt argillite, quartzite with minor igneous, carbonate.

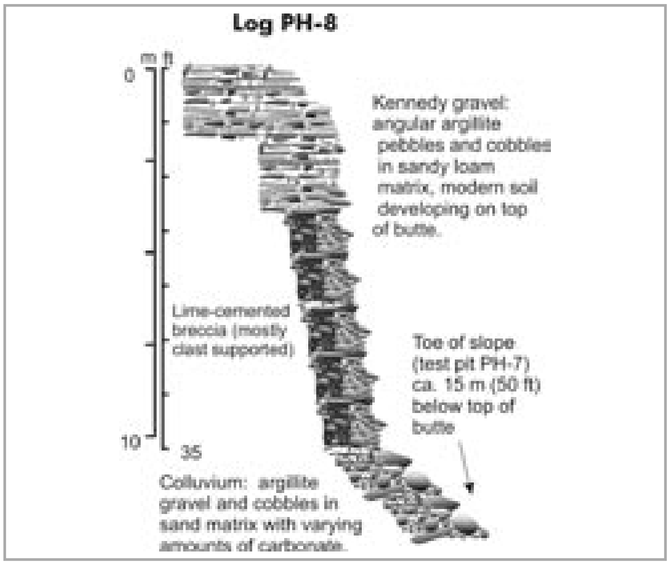

Log PH-1

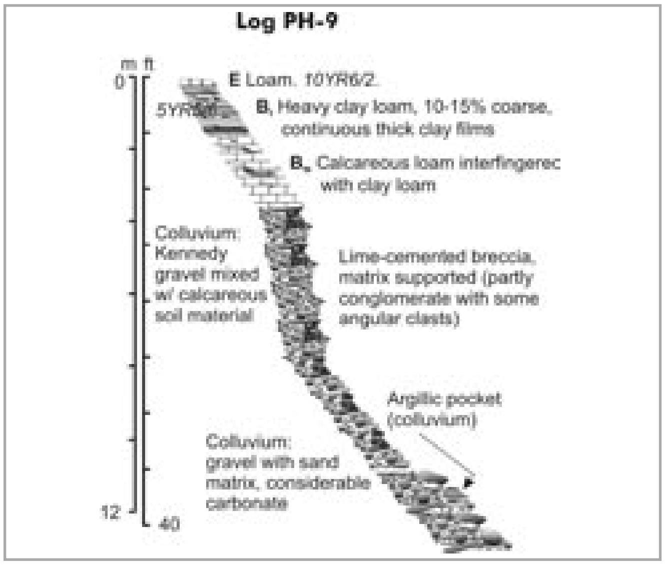

Log SM-9
0"
A Loam, granular
4"
B_t Clay loam
moderate/medium prismatic
Loam - weak, blocky
10"
C Sandy clay with gravel: 10% coarse fragments throughout consisting of 10% igneous, 70% Belt argillite, 15% quartzite, 5% dolostone.
16"
water table
19"
Base trench

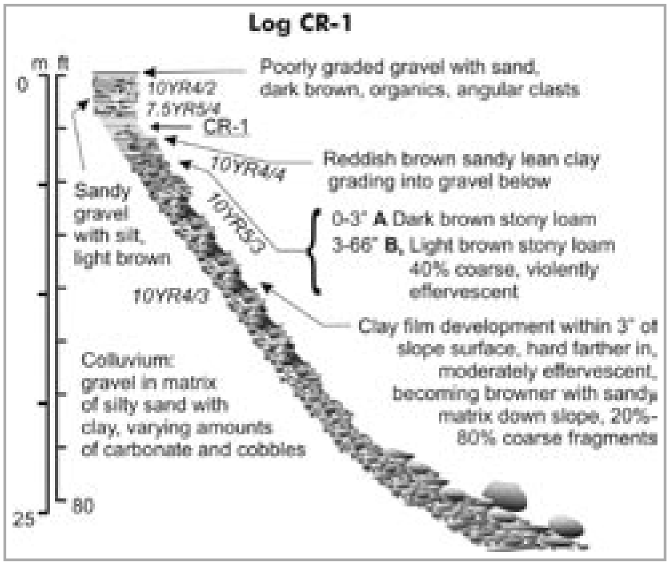

Log PH-2–5
O
0
0
7.5YR5/
E
B_t
5YR4/6
PH-2
PH-3
B
PH-4
PH-5
meters
feet
7
25
Most of slope mantled with gravel veneer (wash). Gravel and slope wash consists mostly of angular pebbles (predominantly argillite).
Heavy clay loam, 25-30% coarse fragments
Clay films thinner and less continuous toward bottom of PH-5.
Colluvium: principally well-graded sand with minor gravel and various inclusions of soil material indicative of down slope movement.


Log PH-6
m ft
0
6
2
E
Buried horizon?
C
Subangular argillite pebble gravel mixed with soil materials and varying amounts of carbonate.
R Weakly cemented, fine-grained, argillaceous, light gray-buff sandstone


Log PH-7
Colluvium
Rim of Mokowan Butte ca. 15 m (50 ft.) above test pit PH-7
0 m ft
A horizon developing on Kennedy colluvium
B_k Horizon exhibits good root development. 7.5YR5/3
C horizon is mixed Kennedy gravel and soil material with varying carbonate content.
Loam
Sandy loam
A
B_k
C
12
4
Sandstone


Log PH-8
m ft
0
Kennedy gravel: angular argillite pebbles and cobbles in sandy loam matrix, modern soil developing on top of butte.
Lime-cemented breccia (mostly clast supported)
Toe of slope (test pit PH-7) ca. 15 m (50 ft) below top of butte
10
35
Colluvium: argillite gravel and cobbles in sand matrix with varying amounts of carbonate.


Log PH-9
m ft
0
E Loam. 10YR6/2.
5YR5/4
B_t Heavy clay loam, 10-15% coarse, continuous thick clay films
B_k Calcareous loam interfingered with clay loam
Colluvium: Kennedy gravel mixed w/ calcareous soil material
Lime-cemented breccia, matrix supported (partly conglomerate with some angular clasts)
Argillic pocket (colluvium)
Colluvium: gravel with sand matrix, considerable carbonate
12
40


Log CR-1
m ft
0
10YR4/2
7.5YR5/4
Poorly graded gravel with sand, dark brown, organics, angular clasts
CR-1
10YR4/4
Reddish brown sandy lean clay grading into gravel below
10YR5/3
Sandy gravel with silt, light brown
0-3" A Dark brown stony loam
3-66" B_k Light brown stony loam 40% coarse, violently effervescent
10YR4/3
Clay film development within 3" of slope surface, hard farther in, moderately effervescent, becoming browner with sandy matrix down slope, 20%-80% coarse fragments
Colluvium: gravel in matrix of silty sand with clay, varying amounts of carbonate and cobbles
25
80

Acknowledgements

We gratefully acknowledge the Blackfeet Nation for permission to perform research on tribal land, and our work benefited from the able assistance of Gabriel Renville, Timothy Sollid, Raymond Strom, Arden Sunwall, and David Sunwall. A significant portion of the fieldwork for this project was funded by a grant from the Creation Research Society. We benefited from the editorial assistance of John Reed and the anonymous reviewers. Finding some of the sites and the individuals who assisted us was clearly providential. *Deum laudamus* (Proverbs 16:9).

Glossary

alfisol: the soil order characterized by a subsurface diagnostic horizon in which silicate clay has accumulated by illuviation; this clay-rich horizon is only moderately leached, and its cation exchange capacity is more than 35% saturated with base-forming cations. Alfisols formed under a forest canopy typically have a leached, light-colored E horizon subjacent to the A horizon.

argillic: said of a soil horizon high in argillaceous matter, typically a B_t horizon or illuvial horizon.

colluvial: dominated by earth material transported primarily by gravity.

eluvial: said of a soil horizon (E horizon) characterized by leaching of physils, bases, cations, and other relatively transportable materials, eventually leaving a horizon dominated by quartz and hydrous aluminosilicates: minerals consisting primarily of aluminum, silicon, and oxygen. Physils or clay minerals are aluminosilicates. Hydrous aluminosilicates are the most stable minerals, most resistant to leaching and weathering, in the surficial environment and thus dominate highly leached or weathered soil horizons.

entisol: the soil order characterized by nascent soil development without distinct development of soil horizons.

interfluve: a topographic high of lesser or greater relief between two drainages.

natural history: as used in this paper, *natural history* refers to the history of nature or earth history.

paleopedology: the study of paleosols.

paleosol: a soil horizon preserved through burial or other processes beyond the reach of current soil forming processes.

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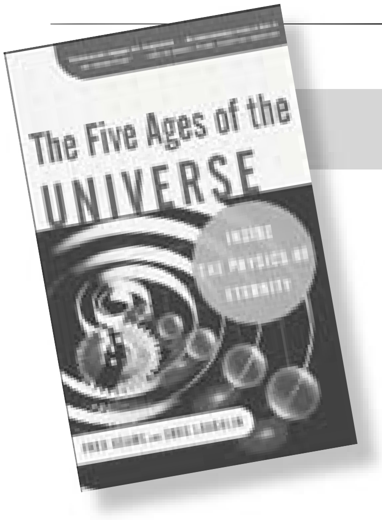

Book Review

The Five Ages of the Universe

by Fred Adams and Greg Laughlin

Touchtone by Simon & Schuster, New York, 1999, 251 pages, $14.00.

The authors are astrophysicists and active members of the Big Bang cosmology establishment with long lists of research publications. Adams is professor of physics at the University of Michigan and Laughlin is a researcher at Lick Observatory. Their book purports to be a detailed biography of the universe from its moment of beginning over 10 billion years ago until its projected death in the distant future. According to the authors, "The Big Bang theory and its modifications provide a highly successful paradigm for describing the origin of the universe, and recent astronomical data place this endeavor on a solid scientific foundation" (p. vii). The book's subtitle is "Inside the Physics of Eternity." Under that theme the authors attempt to fit known physical processes into an eternal cycle of infinite numbers of universes being born and then dying. Only the fortunate ones, where "it is a truly remarkable coincidence that physical laws are just right to allow for our existence" (p. 199) can support the evolution of life as we know it. In my opinion this *multiverse* concept of space-time is ambiguous when used with unbounded universes. The authors use a *causal effect* criteria to define our universe. Anything beyond the distance resulting from the age of the universe times the speed of light is outside of our universe and has no effect on us. They neglect the possibility of interference effects of another universe just outside ours on the outliers of our universe, especially if the universes started at different times and have different physical constants. The book has six main chapters, glossary, notes, references for further reading, listing of key events, and an index. The chapters describe the five ages or eras of the universe starting with primordial and progressing thru stelliferous, degenerate, black hole, and dark eras. The authors define the new term *cosmological decade* as the exponent to base 10 of the time in years since the Big Bang. Notice the utility of this definition as it puts the time of the Big Bang at minus infinity and allows the evolutionists to adjust the time scale to fit any scenario they wish. One problem is the jump from minus infinity to the first finite event. Evidence for this quantum leap is missing. The first event after the Big Bang which the authors mention is the Planck epoch that takes place in the -50.5 decade (10^{-44} seconds). The primordial age ends by decade 5 (less than 10 thousand years of age) and the present age of star formation and dying begins in decade 6. According to the standard theory we are living in the 10th decade (more than 10 billion years old). Ages beyond the stelliferous era are science fiction rather than fact since they start at decade 14 (1 followed by 14 zeros, or 100 trillion years in the future). The authors do not provide a mechanism for the start of star and galaxy formation. They attempt to extrapolate presently known processes into far off ages and believe this makes the book unique and interesting. In reality it is very speculative and only useful for entertaining readers interested in science fiction. The parts of the book I found interesting are the primordial era and two small sections of the dark era. Here the authors explain their concepts of universe birth and evolution. Most interesting is what must happen soon after the Big Bang (within one second) in order for a universe like ours to evolve. They use the language of quantum mechanics where tunneling can cause phase transitions. A summary of the phase transitions taking place in universe evolution is given (p. 177). During this same time period (<1 second) the radius of our universe must change by greater than 10^{30} times even though it was infinite at the beginning (p. 5). They call Alan Guth's inflation theory counterintuitive (p. 3), but necessary to explain the resulting size of the universe observed by telescopes today. Again this strikes me as ambiguous because if it were infinite to begin with why would it have to expand? They claim it got its boost from the vacuum energy density that is naturally located in space throughout the universe. As you can see from the numbers, the inflation takes place faster than the speed of light. This speed is supposedly not a problem since space-time itself is expanding and not something embedded within it. In the last chapter the authors discuss "child universes" that could be forming from black holes in our universe. Thay propose this could lead to a Darwinian view where the offspring universes retain certain physical laws exactly the same, or slightly modified from the parent. The next step would be a Darwinian type of evolution on a universe scale. These authors do not miss any opportunities to promote their evolutionary faith in time, matter, and change: "Our universe, for whatever reason, has the proper characteristics to live for a long time and produce many stars and many galaxies—our own universe is successful according to this grand Darwinian scheme" (p. 203). They do not put a definite end time on this story. It is the authors' opinion that the universe will never cease its changing ways and it is just a lack of imagination or knowledge that limits mankind's view of the distant future. In my opinion, one statement they make is true: "Undoubtedly some readers will feel that we have been far too arrogant in extending the story this far," (p. 205).

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Was Charles Darwin a Racist?

Jerry Bergman*

Abstract

It is widely acknowledged that Darwinism contributed to the problem of nineteenth and twentieth-century racism. It is sometimes claimed, however, that Darwin himself was not a racist but rather that others misused and even misquoted his writings. In this paper I explore Darwin's own views as recorded in his own writings. Darwin clearly held beliefs that today would be considered blatantly racist. It also is true that his writings made a major contribution to the problem of racism and were widely used to support racism. Darwin's conclusions were in stark contrast to the historical Christian biblical view that all humans are siblings, descendants of the first humans Adam and Eve, who were created about six thousand years ago.

Introduction

Darwinism has made a major contribution to many social problems including racism, sexism, capitalism, communism, and even Nazism (Bergman, 1993, 1999, 2001, 2002a, 2002b, 2002c, 2004). Racism is the belief that biological differences in humans create a hierarchy that allows some races to be ranked as superior and others as inferior. It has been used to exclude certain groups, such as African Americans, from full rights in American society. The topic of racism is very important to understanding Darwinism because Darwin's theory of biological origins appears to have reflected his personal attitudes toward people of non-Caucasian races.

Darwin's attitude toward non-Caucasians was hinted at very early in his life. In the early 1800s, for example, Darwin was concerned that his brother, Erasmus, might marry the author and reformer Harriet Martineau (1802–1876). Charles Darwin wrote to his sister Caroline about his concerns, stating that, if Erasmus marries her, he will not be "much better than her 'nigger.'—Imagine poor Erasmus a nigger to so philosophical & energetic a lady." Darwin concluded, "Perfect equality of rights is part of her doctrine. I much doubt whether it will be equality in practice. We must pray for our poor 'nigger'" (Darwin, 1985, pp. 518–519). In Darwin's defense, it should be noted that Africans were commonly called "niggers" in his day and the words "colored" or "black" are twentieth-century terms. Granted, a major argument supporting the view that Darwin was not a racist is that he opposed slavery, as did most people in his social class. His opposition to slavery, however, must be put into context with his other statements about human races, which I will now briefly review.

Racism Was Common in Darwin's Writings

The concept of race was critical to Darwinian theory, because Darwinism required the conclusion that some races were superior and therefore would eventually win out in the struggle for life. Darwin based his conclusion on the fact that there exist observable biological differences, not only between animal kinds, but also within *any one* animal kind. The theory went beyond this, however, and argued that such differences can aid an organism in the struggle for life against other creatures, both those of its own kind and those of other kinds.

Some of these differences in animal populations confer an evolutionary advantage that allows an animal to out-compete other animals in the evolutionary struggle for life. Darwinists

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reason that a rabbit that can run slightly faster or has slightly better hearing than other rabbits is more likely to escape its enemies and is more likely to survive to pass on this advantage to its offspring. It is, in short, superior. The same is true of other races (breeds) of animals. The complete title of Darwin's most famous work, *The Origin of Species*, was *The Origin of Species by Means of Natural Selection or the Preservation of Favored Races in the Struggle for Life*.

The "favored races" expression is obviously racist and was central to Darwin's ideas, as elaborated in Darwin's later writings. Even though Charles Darwin did not even discuss human evolution in *The Origin of Species*, he did draw racist conclusions in his 1871 book *The Descent of Man*. It was also obvious in *The Descent of Man* that Darwin's remarks about animal races, which Darwin had discussed in 1859, he applied to humans, especially in chapter 7, titled "On the Races of Man." This almost 40-page-long chapter covers in detail his conclusions about human races.

Darwin's Racism and the People of Tierra del Fuego

Although Darwin first discussed human evolution in the book *The Descent of Man and Selection in Relation to Sex* (1871), he wrote much about the various human races in earlier books, beginning with the very first book he published, his 1839 *Journal of Researches*. In this early work, Darwin discussed in detail his perceptions of different races. When the exploratory ship *Beagle*, on which Darwin was the naturalist, first visited Tierra del Fuego at the southern tip of South America in 1833, Darwin's original reaction was one of shock at the natives. He described them as "savages" who were "without exception the most curious and interesting spectacle I had ever beheld" (Darwin, 1839, p. 228).

Darwin then superimposed animal traits and imagery on these people. He concluded from his interactions with the Tierra del Fuego natives that he found it hard to believe "how wide was the difference, between savage and civilized man," which Darwin concluded was "greater than between a wild and domesticated animal, in as much in man there is a greater power of improvement" (Darwin 1839, p. 228). He added that they were a "very different race from the stunted miserable wretches further to the Westward" (Darwin, 1839, p. 228). He concluded that the del Fuego natives resembled the devils that come on the stage in such plays as *Der Freischutz* (see Darwin, 1839, p. 228).

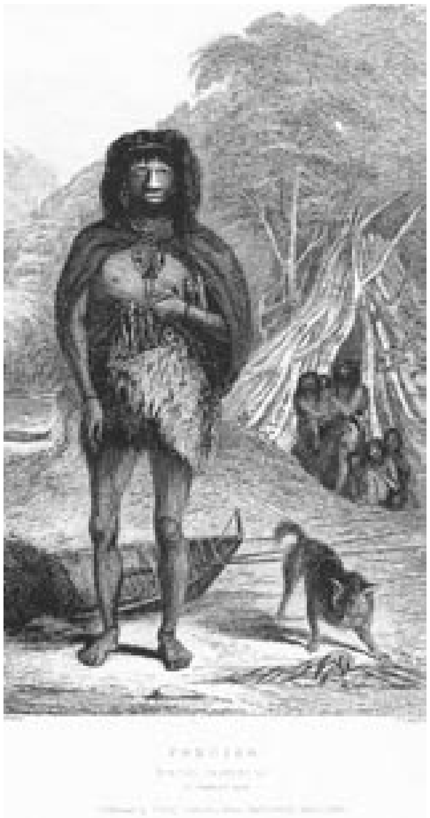

Figure 1. A Fuegian Indian in native dress with a typical family dwelling in the background. Drawn by a crewmember of the Beagle. (Reproduced from FitzRoy, 1839.)

This is the first indication in his writings that he saw non-Europeans as "savages," and this bestialized image of them became increasingly dominant in his subsequent writings. This view foreshadowed the evolutionary connections that he later drew, in vivid terms, between humans and animals. After meeting the Fuegians, Darwin concluded they were "the most abject and miserable creatures" he had ever seen, and that these

> poor wretches were stunted in their growth, their hideous faces bedaubed with white paint, their skins filthy and greasy, their hair entangled, their voices discordant, their gestures violent and without dignity. *Viewing such men, one can hardly make oneself believe they are fellow-creatures, and inhabitants of the same world.* It is a common subject of conjecture what pleasure in life some of the less gifted animals can enjoy: how much more reasonably the same question may be asked with respect to these barbarians. At night, five or six human beings, naked and scarcely protected from the wind and rain of this tempestuous climate, sleep on the wet ground coiled up like animals (Darwin, 1839, pp. 235–36, emphasis mine).

The language Darwin used to describe these people was "overwhelmingly negative in tone, alternating between uninhibited outbursts of aesthetic revulsion and the recurrent images of bestiality" (Ellingson, 2001, p. 141). For example, Darwin said that in order to obtain food, they "unceasingly" wandered, and could not

> know the feeling of having a home, and still less that of domestic affection; unless indeed the treatment of a master to a laborious slave can be considered as such. How little can the higher powers of the mind be brought into play! What is there for imagination to picture, for reason to compare, for judgment to decide upon? To knock a limpet from the rock does not even require cunning, that lowest power of the mind. Their skill in some respects

> may be compared to the instinct of animals; for it is not improved by experience: the canoe, their most ingenious work, poor as it is, has remained the same, for the last two hundred and fifty years (Darwin, 1839, p. 236).

Comparisons of "primitive" humans with animals in an attempt to bestialize them continued throughout Darwin's later writings. For example, Darwin said that when a European man would display his bare arms to a Fuegian, "they expressed the liveliest surprise and admiration at its whiteness, just in the same way in which I have seen the ourang-outang do at the Zoological Gardens" (Darwin, 1839, p. 189).

Darwin's writings provide another example of his negative attitude toward the "primitive" Fuegians:

> The next morning. . . Jemmy's mother and brothers arrived. . . The meeting was less interesting than that between a horse, turned out into a field, when he joins an old companion. There was no demonstration of affection; they simply stared for a short time at each other; and the mother immediately went to look after her canoe (Darwin, 1896, p. 222).

Darwin's reactions to "civilized" Fuegians were less negative than to other "primitive races," such as the Hottentots, and he even reviewed in some detail their positive qualities, such as their intelligence (see Darwin, 1896, pp. 206–207). Darwin further wrote that although the Fuegians "rank among the lowest barbarians," he was "continually struck with surprise how closely the three natives on board H.M.S. 'Beagle', who had lived some years in England and could talk a little English, resembled us in disposition and in most of our mental faculties" (Darwin, 1871, p. 34). Darwin concluded that the lowly nature of Fuegians could be changed.

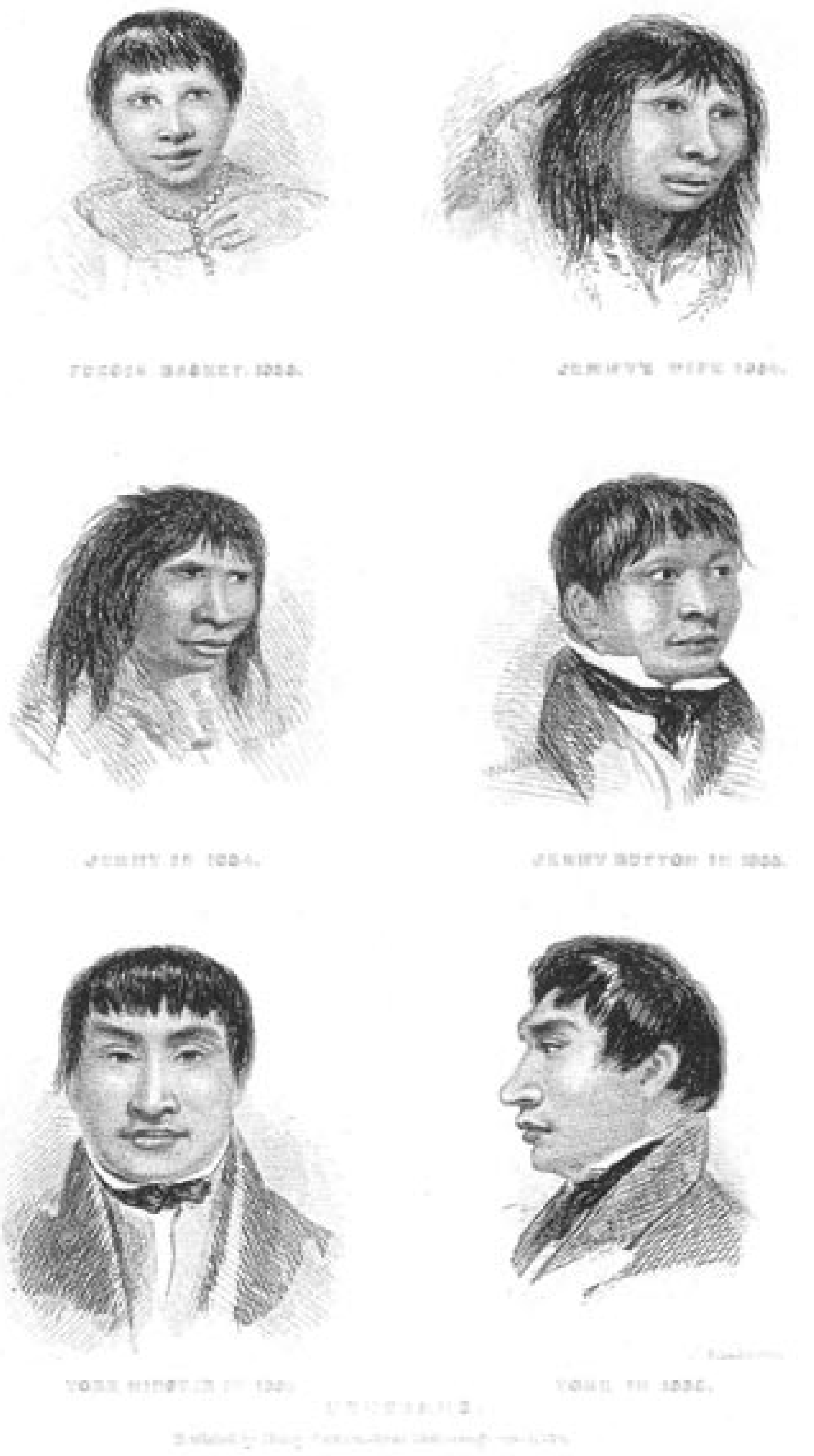

Figure 2. Fuegian Indians in native dress and in European attire. Top left: Fuegia Basket in 1833. Top right: Jemmy Button's wife in 1834. She was "decidedly the best looking female in the company," according to Lieutenant Sulivan (Hazlewood, 2000, p. 148). Middle left: Jemmy Button in his native dress, 1833. Middle right: Jemmy Button in European dress. Bottom left: York Minister in 1832. Bottom Right: Jemmy Button in 1834. All drawings were made by a crewmember of the ship Beagle. (Reproduced from FitzRoy, 1839.)

Darwin's Use of the Term "Savages"

Darwin consistently called the inferior races, including both the native South Americans and the native Australians, "savages" and "barbarians" (see Darwin, 1859, pp. 18, 34, 36, 198, and 215). Most telling is Darwin's suggestion that the inferior "savage races" eventually would be eliminated by natural selection. In Darwin's words: "At some future period, not very distant as measured by centuries, the civilised races of man will almost certainly exterminate and replace throughout the world the savage races" as part of the process of evolution by natural selection (Darwin, 1871, p. 201). He also wrote in 1881 that in the future "an endless number of the lower races will have been eliminated by the higher civilised races throughout the world" (Darwin, 1893, p 69).

Darwin likewise concluded that the anthropomorphous apes will also "no doubt be exterminated" by natural selection (1871, p. 201). After this extinction, Darwin believed that the break between humans and apes "will then be rendered wider, for it will intervene between man in a more civilised state, as we may hope, than the Caucasian, and some ape as low as a baboon, instead of as at present between the Negro or Australian and the gorilla" (Darwin, 1871, p. 201).

In Darwin's chapter on human races in volume 1 of his *The Descent of Man*, he admitted that "even the most distinct races of man, with the exception of certain negro tribes, are much more like each other in form than would at first be supposed" (Darwin, 1871, pp. 215–216). Nonetheless he added that there is

> no doubt that the various races, when carefully compared and measured, differ much from each other,—as in the texture of the hair, the relative proportions of all parts of the body, the capacity of the lungs, the form and capacity of the skull, and even in the convolutions of the brain ... The races differ also in constitution, in acclimatisation, and.... Their mental characteristics are likewise very distinct; chiefly as it would appear in their emotional, but partly in their intellectual, faculties. Every one who has had the opportunity of comparison must have been struck with the contrast between the taciturn, even morose, aborigines of S. America and the lighthearted, talkative negroes (Darwin, 1871, p. 216).

An evaluation of these statements indicates that these ideas were Darwin's own beliefs and not those of other persons. Evidence for this conclusion includes the fact that Darwin did not attribute them to others even though he used many thousands of references and quotes in his writings. In his study of Darwin, Ellingson (2001) concluded that Darwin's writings included the "constant play of bestial similes, metaphors, and comparisons" that represent "Darwin's protoevolutionary thinking." Ellingson adds that Darwin's "rhetoric is very difficult to distinguish from other bestializers of the 'savage', such as Volney or the American racist anthropologists" (pp. 141–142). It also is clear that Darwin's latter works reflected the beliefs of many nineteenth-century Europeans that they were superior to other races. Darwin's discussions in the *Descent of Man* (1871) were

> written after, and partially in response to, the ascent of scientific racism to a position of dominance in British anthropology. Darwin's later discussions of race do show an unfortunate degree of accommodation with some of the ideas of the racist anthropologists; and his negative representation of the Fuegians would be used by those with overtly racist agendas as "scientific evidence" in support of their position (Ellingson, 2001, pp. 141–142).

Darwin interviewed Jemmy Button and the other Fuegian passengers during his long voyage but quickly grew frustrated with, in his words, "their apparent difficulty in understanding the simplest alternative" (Darwin, 1896, p. 208). He argued that the communication problem existed because the Fuegian adults possessed the mental maturity of young children.

> Every one accustomed to very young children, knows how seldom one can get an answer even to so simple a question as whether a thing is black *or* white; the idea of black or white seems alternately to fill their minds. So it was with these Fuegians, and hence it was generally impossible to find out, by cross-questioning, whether one had rightly understood anything which they had asserted (Darwin, 1896, p. 208).

Darwin's Attitude Toward Those He Called Savages

Darwin's attitude toward those persons he called "savages" is very obvious in his discussions. He wrote that after he spent some time with "these savages" in the ship, he came

> to hate the very sound of their voices, so much trouble did they give us.... On leaving some place we have said to each other, "Thank Heaven, we have at last fairly left these wretches!" (Darwin, 1839, p. 241).

Darwin did not expect much of such people, and he generalized about what he called their childishly undeveloped intellects compared to other people. He concluded that Europeans are under a great disadvantage

> when treating with savages like these, who have not the least idea of the power of fire-arms ... Nor is it easy to teach them our superiority except by striking a fatal blow. Like wild beasts they do not appear in all cases to compare numbers; for each individual if attacked, instead of retiring, will endeavour to dash your brains out with a stone, as certainly as a tiger under similar circumstances would tear you ... We can hardly

> put ourselves in the position of these savages, to understand their actions ... a body being invisible from its velocity, would perhaps be to him an idea totally inconceivable ... savages of the lowest grade, such as these of Tierra del Fuego, have seen objects struck, and even small animals killed by the musket, without being in the least aware how deadly an instrument it was (Darwin, 1839, pp. 239–240).

Darwin concluded that the Fuegians were like wild beasts because, he erroneously concluded, they did not respond normally to physical threats. His only evidence consisted of observations such as the fact that they did not run away when a pistol was fired in the air as he expected (see Darwin, 1839, p. 239). This response is not surprising because when Darwin visited them, the Fuegians had been in contact with Europeans and their weapons for over three hundred years. They were, no doubt, by then used to hearing weapons fired. Smith concludes that "the only evidence Darwin was looking for was the minimum needed to justify the placement of the Fuegians in a predetermined taxonomic niche, the 'savage slot' ... in the evolutionary hierarchy of cultures" (as quoted in Trouillot, 1991, p. 17).

Darwin Taught that Differences in Human Groups Reflect Different Levels of Evolutionary Development

For Darwin, perceived differences of relative states of evolutionary development from savagery to civilization energized his views. As Ellingson (2001, p. 143) noted, for this reason, Darwin saw differences even between human groups that were physically very similar. He suggested that although New Zealanders belong to the same human racial group as the Tahitians, in comparison New Zealanders were clearly inferior. Darwin (1839) concluded that the New Zealander

> may, perhaps, be superior in energy, but in every other respect his character is of a much lower order. One glance at their respective expressions brings conviction to the mind, that one is a savage, the other a civilized man (p. 501).

Darwin (1839) added that the Tahitians were "like amphibious animals in the water" (p. 486). Darwin (1859) also noted that he thought the Hottentots were one of the lowest races in existence, even lower than the Negro, and "if it could be proved that the Hottentot had descended from the Negro, I think he would be classed under the Negro group, however much he might differ in colour and other important characters from Negroes" (p. 424).

Darwin's List of Inferior Humans

Brantlinger (2003) concluded that natural historians and "race scientists" from

> Darwin down to World War II hierarchized the races, with the white, European, Germanic, or Anglo-Saxon race at the pinnacle of progress and civilization, and the "dark races" ranged beneath it in various degrees of inferiority. ...Johannes Fabian writes of the "denial of coevalness" to those identified as primitive or savage. The term "Stone Age" applied to modern Australians or Bushmen is an obvious example: the illusion that certain people, races, or cultures are unable to speak the present and future tenses of history is implicit in the words *primitive* and *savage* (p. 2).

The humans that Darwin concluded were "inferior" included Hottentots, Negroes, New Zealanders, Australians, Tahitians, Fuegians and certain other groups. The "superior" peoples included the Europeans. The superior individuals he taught descended by evolution "from barbarians" (Darwin, 1871, p. 404). The barbarians to whom Darwin referred included the Fuegians, because "such were our ancestors" (Darwin, 1871, p. 404). He also concluded he would rather be descended from a "little monkey" or an "old baboon" than from "a savage who delights to torture his enemies, offers up blood sacrifices, practices infanticide without remorse, treats his wives like slaves, knows no decency, and is haunted by the grossest superstitions" (Darwin, 1871, p. 405).

Darwin's importance to the eventual development of racism has been carefully summarized (see Bradley, 1978, pp. 39–40). In one of the most detailed studies of Darwin's views on human race, Greene (1981) concluded that

> what we call "social Darwinism"—the belief that competition between individuals, tribes, nations, and races has been an important, if not the chief, engine of progress in human history—was endemic in much of British thought in the mid-nineteenth century, ... [and] Darwin's *Origin of Species* gave a powerful boost to this kind of thinking, and that Darwin himself was deeply influenced by this current of thought (p. 123).

Darwin's Conclusion about the Fuegians

A major conclusion Darwin drew from his encounters with the Fuegians was that they had a very low place in the hierarchy of human development

> in this extreme part of South America, man exists in a lower state of improvement than in any other part of the world ... The Australian, in the simplicity of the arts of life, comes nearest the Fuegian: he can, however, boast of his boomerang, his spear and throwing-stick, his method of climbing trees, of tracking animals, and of hunting. Although the Australian may be superior in

> acquirements, it by no means follows that he is likewise superior in mental capacity: indeed, from what I saw of the Fuegians when on board, and from what I have read of the Australians, I should think the case was exactly the reverse (Darwin, 1896, p. 230).

By saying "the case was exactly the reverse," Darwin meant that the Australian was the "leading contender [for] the world's ultimate savage, the lowest of the low" (Ellingson, 2001, p. 147). He saw the existence of "savages," and the range of human races—from the lowest to the highest races—as clear evidence that our higher mental faculties "have been gradually developed" by evolution (Darwin, 1871, p. 35). Darwin even argued that "there is no fundamental difference between man and the higher mammals in their mental faculties" (Darwin, 1871, p. 35).

Another conclusion Darwin drew from his ethnographic foray also reflected his attitude that the equality among individuals of the Fuegian tribes

> must for a long time retard their civilization. As we see those animals, whose instinct compels them to live in society and obey a chief, are most capable of improvement, so it is with the races of mankind. Whether we look at it as a cause or a consequence, the more civilized always have the most artificial governments ... In Tierra del Fuego, until some chief shall arise with power sufficient to secure any acquired advantages ... it seems scarcely possible that the political state of the country can be improved. At present ... no one individual becomes richer than another. On the other hand, it is difficult to understand how a chief can arise till there is property of some sort by which he might manifest and increase his authority (Darwin, 1839, p. 242).

Darwin expressed his conclusion that the native people are in the ultimate state of savagery and actually argued that their low state is too egalitarian to permit the improvements that are needed to allow some Fuegians to accumulate the property, wealth, and power necessary to produce a more developed society. Ellingson (2001) concluded that the

> most problematic feature of Darwin's ethnography is not its racism but its ethnographic shallowness. Of course, the *Beagle's* sailing schedule, and Darwin's primary interest in and commitment to other scientific research subjects, did not allow for extended residence with a people or for participant-observation ethnography, if such an idea had even occurred to him. Nor did the company of his companions on the ship, with their military preoccupations and defensive hostility to the natives, encourage sympathy or even closer contact with the Fuegians (p. 144).

Darwin Believed the Fuegians were Incapable of Being Evangelized

One of the most telling indicators of Darwin's attitude toward the Fuegians that revealed "the true depth of his racism ... was his belief that the Fuegians were incapable of being evangelized" (Lubenow, 2004, p. 145). Darwin knew enough about the Scriptures to realize that all humans and only humans could be evangelized. Lubenow writes that "Darwin often compared the Indians of Tierra del Fuego to animals" and probably the

> best evidence of how lowly he viewed the Fuegians is seen in how he viewed them spiritually ...The holy Scriptures make a clear and qualitative distinction between all humans and all animals. In Genesis 9, God gives the humans the right to use any and all animals for food. Yet human life is protected as sacred because we are made in God's image. Anyone who kills a human being in what we call "Murder 1" must forfeit his own life. [Darwin] ... having studied for the ministry at Cambridge ... had to be aware of the distinction that Scripture makes between humans and animals ... Although Darwin later denied human uniqueness, he was aware that the Bible taught that only humans were created in God's image and that Christ commanded his disciples to evangelize all humans (Lubenow, 2004, p. 145).

Lubenow (2004) then quoted Admiral Sir James Sulivan, who as a lieutenant was a shipmate with Darwin on the *Beagle*:

> Mr. Darwin had often expressed to me his conviction that it was utterly useless to send Missionaries to such a set of savages as the Fuegians, probably the very lowest of the human race. I had always replied that I did not believe any human beings existed too low to comprehend the simple message of the Gospel of Christ (pp. 145–146).

Darwin eventually realized that missionary activity was possible (and could be successful) even among the Fuegians. To Darwin's credit,

> he admitted he was wrong. In a letter to Sulivan, dated 30 June 1870, Darwin wrote, "... the success of the T. del Fuego mission ... is most wonderful, and shames me, as I always prophesied utter failure." In another letter to Sulivan, dated 20 March 1881, Darwin wrote, "I ... predicted that not all the Missionaries in the world could have done what has been done" (Lubenow, 2004, pp. 145–146).

Lubenow (2004) concluded by noting that, although Darwin lived in a racist society,

> the fact that Darwin would have denied the Indians of Tierra del Fuego the gospel, whereas other Englishmen at great sacrifice did give those same Indians the gospel, suggests that his incipient ideas on

> evolution, even at that early date, caused Darwin to be even more racist than some of his peers. And the theory of evolution he developed is equally racist (p. 146).

Accounts of Fuegians by Others Were Not Racist

Descriptions of the Fuegians by other people who visited them during the same period in which Darwin wrote help us to appreciate the extent of Darwin's unjustified negative view of them. Charles Wilkes, commander of the United States Exploring Expedition, visited Tierra del Fuego only a few years after Darwin. Wilkes was described by his reviewers as a very perceptive and sensitive observer who had devoted considerable effort in developing a code of conduct for his crew to avoid harming the indigenous peoples that they encountered on their voyages. Wilkes described his encounter with the Fuegians as follows:

> We were here visited by a canoe with six natives, two old women, two young men, and two children.... The expression of the younger ones was extremely prepossessing, evincing much intelligence and good humor. They ate ham and bread voraciously, distending their large mouths, and showing a strong and beautiful set of teeth. A few strips of red flannel distributed among them produced great pleasure; they tied it around their heads as a sort of turban. Knowing they were fond of music, I had the fife played, the only instrument we could muster. They seemed much struck with the sound. The tune of Yankee Doodle they did not understand; but when "Bonnets of Blue" was played, they were all in motion keeping time to it. The vessel at this time was under way, and no presents could persuade them to continue any longer with us.... We found them also extremely imitative, repeating over our words and mimicking our motions. They were all quite naked. I have seldom seen so happy a group. They were extremely lively and cheerful, and anything but miserable, if we could have avoided contrasting their condition with our own (quoted in Ellingson, 2001, pp. 145–146).

Clearly, Wilkes painted a very different picture of the Fuegians than did Darwin.

Darwin's racial negativism was partly a reflection of the belief in white superiority, and the inferiority of the "darker races" that pervaded European society and discourse (scientific as well as nonscientific) in the nineteenth century (Ellingson, 2001). In Darwin's case, he carried his prejudices with him on his journey to Tierra del Fuego so that what appears in his writings to be an objective, rational assessment of non-European peoples and customs based on firsthand, ostensibly scientific, "observation" was, to a significant extent, an artifact that resulted from his racist framework.

Since Darwin's writings were critical in the development of evolutionary theory, his thoughts on the application of his own racism to evolution are crucial to understanding the history of racism. While he was far less racist than many of his disciples (such as Spencer, Haeckel, Hooton, Pearson, and Huxley), Darwin's theory provided the *basis* for their extreme racism as expressed in the eugenics movement. Darwin's works also supported the polygenist view of human origins in the major nineteenth-century debate between monogenism and polygenism (the view that all humans had one ancestor versus the view that we had several ancestors) regarding the origin of the races.

Darwin's Support of Eugenics

Although known as a kind and gentle man, Darwin openly supported the racism that his theory permitted. Darwin also generally supported eugenics, even though he opposed some of the extreme forms espoused by many in his day. A major source of the racism inspired by Darwinism came, not from Darwin himself, but from the pen of Darwin's cousin, Francis Galton. Darwin was fully convinced that eugenic theory was valid, and he "canonized Galton with the words; 'we now know, through the admirable labours of Mr. Galton, that genius ... tends to be inherited'" (Kevles, 1985, p. 20). Darwin clearly agreed with eugenic ideas. After reading *Hereditary Genius*, one of Galton's major works supporting eugenics, Darwin wrote to Galton on December 3, 1869, that "I do not think that I ever in my life read anything more interesting and original ... you have made a convert of an opponent ... a memorable work" (quoted in Gillham, 2001, p. 169). Darwin ended his book on human evolution with these words:

> The advancement of the welfare of mankind is a most intricate problem ... as Mr. Galton has remarked, if the prudent avoid marriage, whilst the reckless marry, the inferior members tend to supplant the better members of society. Man, like every other animal, has no doubt advanced to his present high condition through a struggle for existence consequent on his rapid multiplication; and if he is to advance still higher he must remain subject to a severe struggle. Otherwise he would soon sink into indolence, and the more highly-gifted men would not be more successful in the battle of life than the less gifted.... There should be open competition for all men; and the most able should not be prevented by laws or customs from succeeding best and rearing the largest number of offspring (Darwin, 1871, p. 403).

It should be noted that because Darwin agreed with Galton does not in itself show that Darwin fully supported the eugenics that many of Galton's followers advocated. Darwin was favorable to the fundamental presuppositions of eugenics, but insisted that eugenic programs should be voluntary and not mandated by the state. Darwin and many others agreed with Galton on the issue of biological determinism of both intellectual and moral traits. The coercive ideology was primarily what later created the controversy over eugenics. Although Darwin's support for Galton and eugenics did not directly extend to overt racism, Darwin's works have inspired many coercive eugenic advocates, including current prominent racists, such as David Duke (Duke, 1998).

The Biblical View of Man

The Scriptures and all three "religions of the book"—Jews, Muslims, and Christians—teach that all humans descended from one man and woman, Adam and Eve, thus all are brothers and all races are equal before God (Ham et al., 1999). For example, Paul in his message on Mars Hill taught that God made every race of men out of one man (Acts 17:26). Although some Christians such as Weisman (1996) have used the Scriptures to justify their own racism, such as the belief that the curse of Ham produced the black race, these ideas have been extensively refuted and were never widely accepted (see Ham et al, 1999). Weikart (2004) concluded that

> racism obviously predated Darwinism, but during the nineteenth century—in part through the influence of Darwinism—it would undergo significant transformations. Before the nineteenth century, the intellectual dominance of Christianity militated against some of the worst excesses of racism. Christian theology taught the universal brotherhood of all races, who descended from common ancestors—Adam and Eve. Most Christians believed that all humans, regardless of race, were created in the image of God and possessed eternal souls. This meant that all people are extremely valuable, and it motivated Europeans to send missionaries to convert natives of other regions to Christianity. As contact with other races increased during the nineteenth century, the Protestant missionary movement blossomed, sending out multitudes of missionaries to convert non-European peoples to Christianity.... Even though some Christian groups, especially in lands with race-based slavery, developed theological justifications for racial inequality, most Christian churches believed that people of other races were valuable and capable of adopting European religion and culture (p. 103).

Conclusion

Anthropologist Marvin Harris and others, based on evidence such as outlined above, have "not hesitated to call Darwin a 'racist'" (Greene, 1981, p. 95). Supporters for this view "have no difficulty in finding passages [in Darwin's writings] that seem to out-Spencer Spencer," the extreme social Darwinist and racist (Greene, 1981, p. 96). The fact that Darwin was not consistent, indicating he held mixed views at different times in his life, does not negate his racism. It is clear that Darwin's racist ideas were exploited by his followers, especially those who already had developed racist ideas and prejudices, to support their own racist beliefs. For example, Darwin described the Fuegians and other non-Caucasians as "savages of the lowest grade [and] miserable, degraded savages" who are living in a "savage land" and in "a savage state" with a "wild cry" as they roam around like "wild beasts" (Lubenow, 2004, p. 143). It also is clear from the writings of racists that many of them used Darwin as support for their racism (Duke, 1998). From this review, it is easy to understand why they used Darwin's words to support racism.

In an attempt to obscure the charge that Darwin held racist ideas, his defenders often point to the fact that Darwin opposed slavery and approved of missionaries going to Africa. This behavior, although inconsistent, strongly reflected the views of his social class. Even though he held racist views, Darwin did not approve of brutality, and he did support humanitarian efforts to help other races. He also supported limited animal "rights." For example, he opposed mistreatment of dogs. Many racists today, such as David Duke, also claim that they oppose mistreatment of minorities and dogs, but this does not negate either their racism or Darwin's.

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Book Review

Science and Grace: God's Reign in the Natural Sciences

by Tim Morris and Don Petcher

Crossway Books, Wheaton, IL, 2006, 200 pages, $15.00.

Authors Tim Morris and Don Petcher, a biologist and a physicist respectively, are professors at Covenant College. At the outset of *Science and Grace*, they state their commitment to "[refer] directly to Scripture" rather than making their "confessional heritage" their "primary reference" (p. xii). They generally fulfill this commitment, though at times they find themselves talking in exclusively Reformed terms. *Science and Grace* has three broad goals: (1) to show how modern science arose in a Christian framework and has been shifting recently toward a non-Christian post-modern stance; (2) to show how Christ governs the natural realm; and (3) to explain some of the ways in which Christian faith ought to make a biblically-based science distinct from the secular version. Threads addressing each goal are interwoven throughout the book.

Science and Grace is a timely book. The common perception is that Christianity has hindered science rather than facilitating it, so the first goal is a needed corrective. Likewise, a popular idea is that natural law somehow governs the creation, rendering God irrelevant to science, so the case for Christ's governance of creation is a timely topic. Finally, Christians often rationalize ways of blending into the secular landscape, and we need reminders of the need to show our faith openly in all we do, including the practice of science.

Christian Origins and the Post-Modern Shift in Science

Morris and Petcher begin by emphasizing that, "Science has never known a non-Modern backdrop for its operation" (p. 2). This is an amazing statement considering that all non-Western cultures, ancient and contemporary, are thereby excluded from having practiced science. Nevertheless, more than a few historians and philosophers of science concur (e.g., Dawson, 1950, p. 17; Jaki, 1985, p. 42; Quigley, 1961, p. 334). There is a balanced discussion of the Renaissance, "in which the focus was increasingly on man, in contrast to the heavenly themes of the past" (p. 19). This was a productive trend as long as it led to a fruitful study of God's physical creation, but a dangerous trend once Enlightenment advocates sought to co-opt science in a war against Christianity.

Descartes (1596–1650), the "father of the Enlightenment" (pp. 20–21), was a Euclidean in his view of nature as a manifestation of mathematics (Descartes, 1636, p. 7). Although in hindsight we see in Descartes the seeds of what became the mechanistic cosmos of Diderot and Laplace, Descartes in his day was, similar to Francis Bacon (1561–1626), simply opposing the unfruitful search for Aristotelian "first causes." Rather than searching for the first cause in the physical creation, we must search the Scriptures instead, for the Bible clearly points to the Creator as the First Cause who mediates His will through the phenomena known as "natural law." Thus "Descartes and Bacon were ... arguing from within a Christian framework" for a study of the physical creation which would lead to modern science (p. 24). Morris and Petcher rightly conclude that since even the early Renaissance figures operated at least implicitly from a Christian vantage point, there is no case to be made for the origin of modern science being somehow non-Christian.

A recurrent thread in *Science and Grace* concerns the subjectivity associated with interpretations of natural phenomena. A key historical example of this subjectivity is the "Enlightenment project." This was the deliberate effort of skeptics in the 1700s to generate a situation in which "science would be billed as the means to lead humans out of `bondage' to religion" (p. 25). Christianity and the Bible were the real targets. "The project was conceived in 1749 when some Parisian booksellers approached Diderot [1713–1784] about helping with a translation of Ephraim Chambers' *Cyclopedia* into the French language. Diderot convinced them rather to entrust him with an entirely new project" (p. 25). Morris and Petcher cite the 1950 edition of *Chambers' Encyclopedia* as saying that Diderot's revision "would contain articles on all artistic and technical subjects, but under cover of a design apparently disinterested [to be] a means of demolishing 'prejudices,' as Christian beliefs were then called. The leading authorities of the day were enrolled, and also the leading infidels" (pp. 25–26), including Condorcet (1743–1794) and Laplace (1749–1827). Thus Morris and Petcher supply the staggering fact that the current anti-Christian bias in science didn't "just happen," but was premeditated and aggressively implemented.

It was at this time that Isaac Newton's (1642–1727) theory of gravity and laws of motion were reinterpreted to imply a godless, mechanistic universe, a conclusion with which Newton would have disagreed vehemently. This "mechanistic philosophy also began to move into biology in the late eighteenth century, culminating in Darwin's theory of evolution" (p. 28).

With the Enlightenment rejection of God and biblical truth, the inevitable consequence was David Hume's (1711–1776) assertion that reality is only in the mind. Immanuel Kant (1724–1804) refined Hume's ideas, deciding that "the basic notions of our experience were not necessarily `out there,' but they were categories in our mind" (p. 33). Kant therefore "introduced a kind of dualism between science and religion" (p. 34) in which the two were non-complementary mental constructs constituting a kind of "truth," but not the truth revealed in Scripture. The stage was now set for the Enlightenment brand of "science" to displace the Bible, leaving Christian faith valid only in the private sphere, not in public life.

Kant's dualism was actually a reintroduction of the "Two Books" concept enshrined by Aquinas in which science and religion were conceived as mutually exclusive activities with neither informing the other. Scripture teaches (e.g., Romans 1:20) that science and biblical faith are indeed complementary and that God reveals Himself though the physical creation in ways understandable to all men. Kant's reintroduction of the faulty "dual revelation" concept paved the way for Christians later to accept unbiblical theories of origins on the basis that religion reveals who created and why, but that science reveals "how and when" God created. Morris and Petcher appear not to have thought through this issue sufficiently, as will be discussed below.

The Enlightenment rejection of biblical truth reached its zenith in Friedrich Nietzsche (1844–1900), who rejected the notion of universal truths residing in the human mind. According to Nietzsche, "there are no universals; there are only particulars" (p. 37). Nietzsche's position laid the foundation for the current post-modern trend which asserts that no truth exists. The fashionable emphasis on "scientific reductionism" also traces back to Nietzsche. In scientific reductionism, the whole is always the sum of its parts. Reductionism implies that if we dissect life down to the molecular level of the DNA, we can deduce what makes life happen and maybe produce it in the lab. The Human Genome Project has drawn not a little of its inspiration from this hope. According to the Bible, reductionism is not an overarching principle, for after fashioning the human body, God breathed into man the breath of life (Genesis 2:7), a phenomenon that no lab will ever duplicate.

Morris and Petcher assert that science has now become thoroughly post-modern, being a "socially driven" (p. 43) rather than truth-driven enterprise. This judgment is more accurate for the "soft" sciences than for the hard sciences such as chemistry and physics. In the hard sciences a "modernistic" view continues, with practitioners often believing—unbiblically—that they can apprehend universal truths via science (DeWitt, 2004, p. 309).

Christ's Governance of His Creation

Morris and Petcher are right on target in describing how a Christian view of natural law differs from the secular (Enlightenment) version. The two views revolve around whether Christ governs creation or not. Natural law and miracles are both an outworking of God's governance of creation. "Thus both law and miracles are part of God's providential workings in the world" (p. 128). Insightfully, Morris and Petcher observe that "miracles can only be recognized by virtue of their contrast to the backdrop notion of the laws of nature" (p. 136). Further, "law ... is not something that God Himself must obey. Rather it is part and parcel of the way God governs His creation" (p. 142). This fact challenges the origins accommodationists to consider that God was not constrained to follow natural law in the creation week. Morris and Petcher do not follow up on this pregnant thread.

However, the authors do suggest a productive corrective to common notions of quantum mechanical randomness. In opposition to the fashionable post-modern belief that the universe cannot be known nor the future determined even by God, Morris and Petcher say, "There is no reason to believe, according to Scripture, that God is in any way ignorant of the future" (p. 152). Thus not only is the unpredictable future of evolutionary "progress" challenged, but also the emerging heresy called "open theology," which claims that God alters His plans as the future, unknown even to Him, unfolds.

A Science Built on Christian Faith

In discussing the differences that Christian faith ought to make in how one does science, Morris and Petcher rely heavily on the thought of Reformed theologian Abraham Kuyper (1837–1920). Much of what Kuyper wrote about science and theology was a response to the modernism of his day, as well as a response to patterns of theological post-modernism that were emerging in his lifetime. According to Morris and Petcher, "Kuyper explicitly denies the objectivity of a scientific enterprise based on reason and experience alone" (p. 69), and "from Kuyper's point of view, those who insist that there is only one kind of science deny the reality of sin" (p. 73). However, Kuyper hoped "that some common productive work could be done even across the antithetical [Christian/non-Christian] divide in the Calvinist doctrine of common grace" (p. 75). While this sentiment may be realistic in the observations and measurements of the hard sciences, its attainment is questionable in the area of technological application, and in the historical sciences such as geology and cosmology. Christians and non-Christians may observe and measure the same phenomena in the present, but what these data mean for life now, and what they imply for developments in the past, are questions answerable only with reference to revelation. Outside of biblical revelation in which Christian understanding is guided by the Holy Spirit, man is a lie-seeker rather than a truth-seeker (Proverbs 14:12, 16:25).

Following Kuyper, Morris and Petcher rely on the concept of "common grace" to "[keep] the whole enterprise of science on track" (p. 11). Common grace "allows valid insights to be made by those who are not believers in Christ" (p. 75). Morris and Petcher's emphasis on common grace is not surprising, being reflected in the very title *Science and Grace*, but they never specify the insights which common grace confers. However, the commonality which they allege to exist actually weakens their ability to specify how a Christian view of science ought to be different from one that is not Christian. For Morris and Petcher, a Christian approach to science means serving "the Spirit of God" instead of serving "the spirit of an idol" (p. 78), a theme repeated several times throughout the book. This idolatry is not clearly defined, and one concludes that it is perhaps supposed to mean beliefs impinging on science that are unbiblical. Examples of such beliefs are not suggested in the context of mentioning this idolatry.

Thus although Morris and Petcher assert that "the theories of science cannot help but reflect the religious beliefs of those who hold them" (p. 82), they appear to have conflated common grace with general revelation. God's work among humankind involves the general revelation of Romans 1:20, but there is no common grace leading men into truth apart from biblical revelation which the Holy Spirit mediates in the heart of the recipient. General revelation is inferior to special (biblical) revelation (Thiessen, 1949, p. 33), and in itself is no guarantee that fallen man can avoid following lies.

The idea that common grace somehow confers a truth-finding ability may partly explain the tendency of theologians over the past decades to find an accommodation between biblical creation and evolutionary "science." After all, if the scientific consensus is approaching truth, there are no biblical grounds for questioning it. Meredith Kline, for example, has become an outspoken advocate of accommodationist views of origins (Kline, 1996, p. 2). Morris and Petcher quote Kline for support of the belief that God has made a "Covenant of Creation," i.e., a covenant with the creation (p. 99). Morris and Petcher rightly define a covenant as a "binding agreement between two parties" (p. 99), but the Scriptures say nothing of a covenant with the physical creation. In the Bible, God made His covenants with men as rational, responsible parties (e.g., the covenant with Noah, Genesis 9:8–17). The physical creation cannot be a "party" to an agreement. Except for mankind, the physical creation passively experiences the ramifications of covenants that God has made with man, despite Morris and Petcher's reading into the Noachian covenant an alleged agreement with the creation. *Science and Grace* also treats the announcement of the new covenant (Jeremiah 33:20–22) as a covenant with creation. God's governance of the creation is certainly evident in the new covenant, but not a covenant with the physical creation itself.

Morris and Petcher claim that God "appeals to the certainty of His faithful upholding of His decrees governing nature in order to assure His people that the New Covenant will surely be enacted" (p. 102). God had to have made "decrees" to justify the Calvinist view of predestination and divine sovereignty. But in Jeremiah 33:20–22 there is no decree as such, only a proclamation of God's exercise of power over the creation. Perhaps the emphasis on *decree* rather than on God's *power* partly explains the difficulty that theologians like Kline have with God's ability to create by fiat without recourse to long ages and evolutionary mechanisms. After all, accommodationist origins models such as theistic evolution or progressive creation can be seen as processes which God has advanced by making "decrees" as required.

Another difficulty is the tendency of Morris and Petcher to view biblical history as "divine theater" (p. 166) for which we need to develop skills in "story-thinking" (p. 169). Though elsewhere they acknowledge that the Bible is history, recognizing that "words ... are not plastic in an unlimited way" (p. 229), the view of the Bible as "story" weakens our obligation to accept the hard facts of history revealed in Scripture. In particular, the "story" mentality lessens our obligation to accept the creation as a historical event transcending all natural laws. When telling a story, it is easier to focus on the parts that are more natural to our understanding and to ignore the hard parts.Thus it is significant that in this context, Morris and Petcher criticize "the twentieth-century evangelical and fundamentalist fixation on the when and how of creation." According to them, we should be focused on "the more settled

Christian teachings concerning the who (the triune God), what (everything), and why (for His glory) of creation" (pp. 176–177). Unfortunately, Morris and Petcher appear to be unaware that they come close to echoing liberal sentiments on this point (e.g., Gibson, 1981, pp. 2, 11, 13). The "when" and "how" of creation are less settled only with respect to accommodationist views of origins asserting that God must have used evolutionary mechanisms to "create." On the other hand, in other places Morris and Petcher give little ground to biological evolution. They elevate the biblical history of creation instead. They write, for example, that "one doesn't get the idea ... that Adam willy-nilly named the animals in terms of any random impulse that popped into his mind" (p. 214). As for cosmic evolution, they characterize the popular nebular hypothesis as "clearly based on [Laplace's] commitment to a naturalistic explanation of all things" (pp. 317–318).

One wishes that Morris and Petcher had consistently followed through in suggesting that a Christian view of science can answer the hard questions about the when and how of origins. Because of their reluctance to engage such issues, their prescriptions for being different as a believing scientist generally relate only to the private and social spheres, although their prescriptions are certainly biblical as far as they go. For example, "Christians in science should avoid temptations to establish their own credentials by being harshly critical of the work of others" (p. 260). Further, "a Christian is always to have an eye for practical application, especially for applications that soften or counteract the effects of the Fall in God's world" (p. 269). One is here reminded of John Clerk Maxwell's prayer (Campbell and Garnett, 1882, p. 323) in which he made the request we might learn "to study the works of Thy hands, that we may subdue the earth to our use, and strengthen the reason for Thy service; so as to receive Thy blessed Word, that we may believe on Him Whom Thou hast sent, to give us the knowledge of salvation and the remission of our sins."

Morris and Petcher are strongest when discussing the Christian origins of modern science and the shift into postmodernism. Their treatment of Christ's governance of His creation is also well worth reading. Their assessment of Christian distinctives in science is the weakest aspect of *Science and Grace* because of (1) their reliance on common grace as a guide to truth, and (2) their reluctance to tackle some of the hard issues in the biblical presentation of history, especially relating to origins. Nevertheless, the strong points of *Science and Grace* make the book worth reading.

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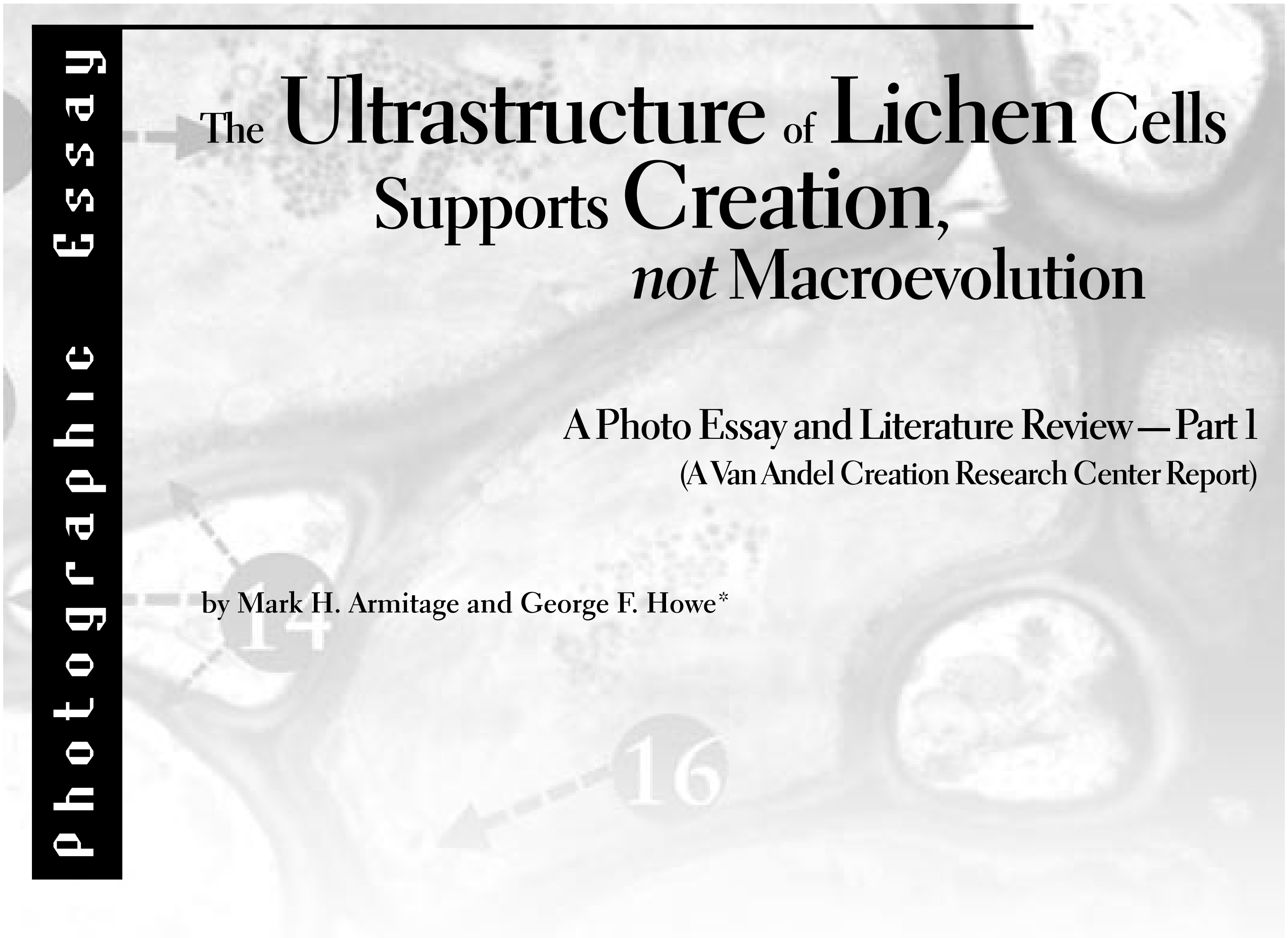
Photographic Essay



The Ultrastructure of Lichen Cells Supports Creation, *not* Macroevolution

A Photo Essay and Literature Review—Part 1

(A Van Andel Creation Research Center Report)

by Mark H. Armitage and George F. Howe*

Introduction

Lichens are a life-form composed of a fungus called the "mycobiont," growing in close union with some alga or blue-green bacterium known as the "phycobiont" (Howe and Armitage, 2002). Some workers consider this to be a symbiotic union, while others see it as a mild form of parasitism. Lichen pigments probably play many important physiological roles, while their brilliant colors provide considerable aesthetic enjoyment (Howe and Armitage, 2003). The versatile array of lichen asexual reproductive bodies and other features of the lichen upper surface have been illustrated by using scanning electron photomicrography (Armitage and Howe, 2004). Lichen algae and fungi are woven together forming "tissues" that resemble the tissues of unrelated "higher plants" in a generalized fashion (Armitage and Howe, 2006).

In this two-part article (our fifth lichen paper) we show that the cellular ultrastructure of lichen provides evidence favoring design and direct creation. Our hope here, as with the other lichen papers, is that the readers' knowledge of the Creator and their esteem for His handiwork will be enhanced by the study of lichens.

Methods

The methods we used in sectioning the lichens and securing the electron photomicrographs are the same as those discussed in previous papers (Armitage and Howe, 2004; 2006).

The Ultrastructure of Lichen Algae and Fungi

Lichens Have Tissues

The cells seen in our Transmission Electron Microscope (TEM) photographs are located either in the algal zone or in the medulla tissue of various lichens (Figure 1). Underneath their protective upper cortex tissue, lichens typically pos-

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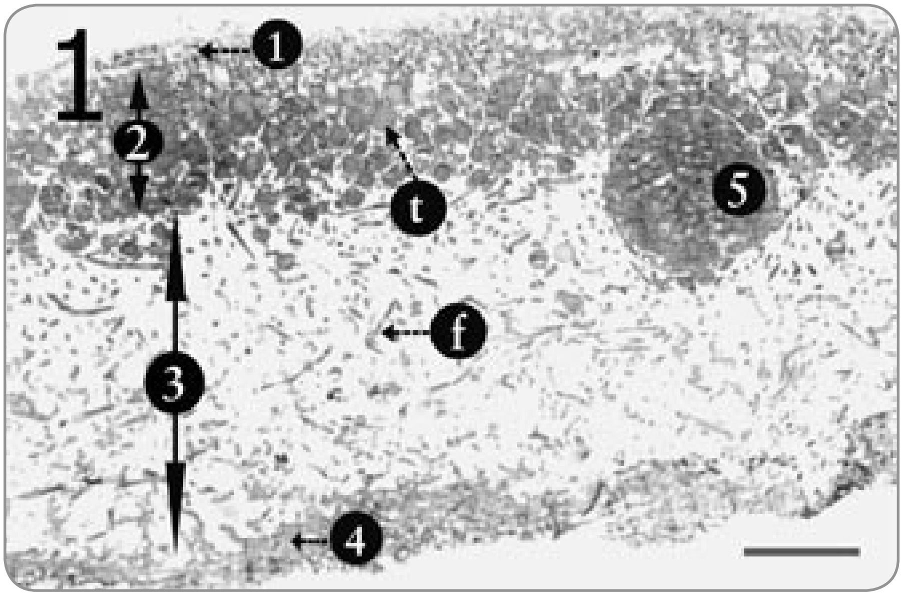

Figure 1. A brightfield photomicrograph of a cross section of a typical foliose lichen *Xanthoparmelia sp.* with its tissue zones labeled. The tissues are: upper cortex (1), algal layer (2), medulla (3), and lower cortex (4). Area (5) appears to be a developing reproductive structure called an *apothecium.* A *Trebouxia* cell in the algal layer is labeled "t," while item "f" is a fungus hypha in the medulla. Lichens are thought to be very distant taxonomically from flowering plants, yet many features found in the tissues of plant leaves are duplicated here in a very generalized fashion (Armitage and Howe, 2004; 2006). A mycobiont produces a complex thallus like this only when it grows with its phycobiont. The same fungus by itself builds no such edifice. This suggests intelligent design. The scale bar is 60 micrometers, and the magnification is 2,000X.

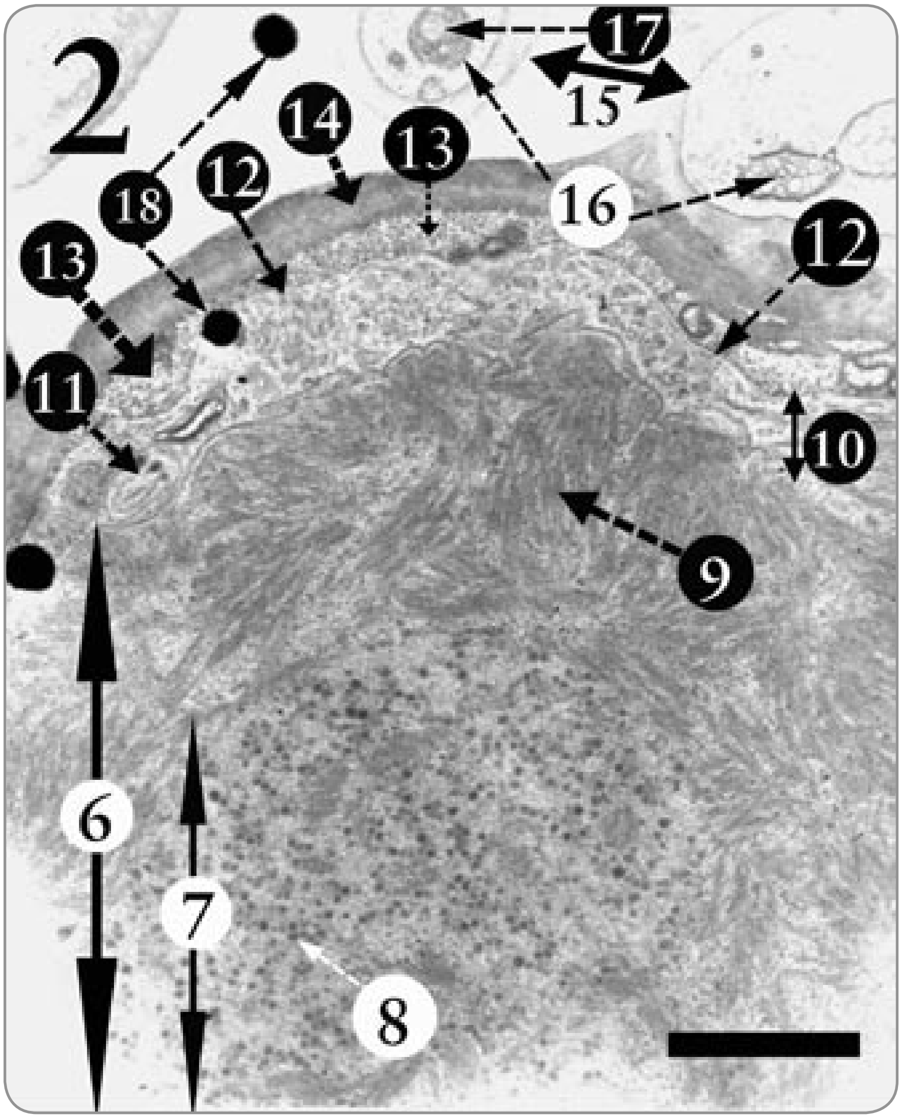

Figure 2. A transmission electron microscope (TEM) photograph of *Trebouxia sp.*, a green alga present in many different lichens, and two accompanying fungal cells from the algal zone of the lichen *Caloplaca sp.* This figure, and all those which follow, are TEM photographs. The numbered visible items here are a cell of the phycobiont *Trebouxia sp.*: chloroplast (6), pyrenoid inside chloroplast (7), pyrenoglobuli (8), thylacoid membranes inside the chloroplast (9), cytoplasm (10), mitochondria (11), cytoplasmic membrane (usually called the *plasmalemma*) (12), storage region just outside the plasma lemma (13), cell wall (14), cell of the fungus in the *Caloplaca* lichen (15), nucleus (16), nucleolus (17), and an artifact (18). Dark dots like these on other figures are artifacts as well. The magnification is 11,000X, and the scale bar is 4 micrometers.

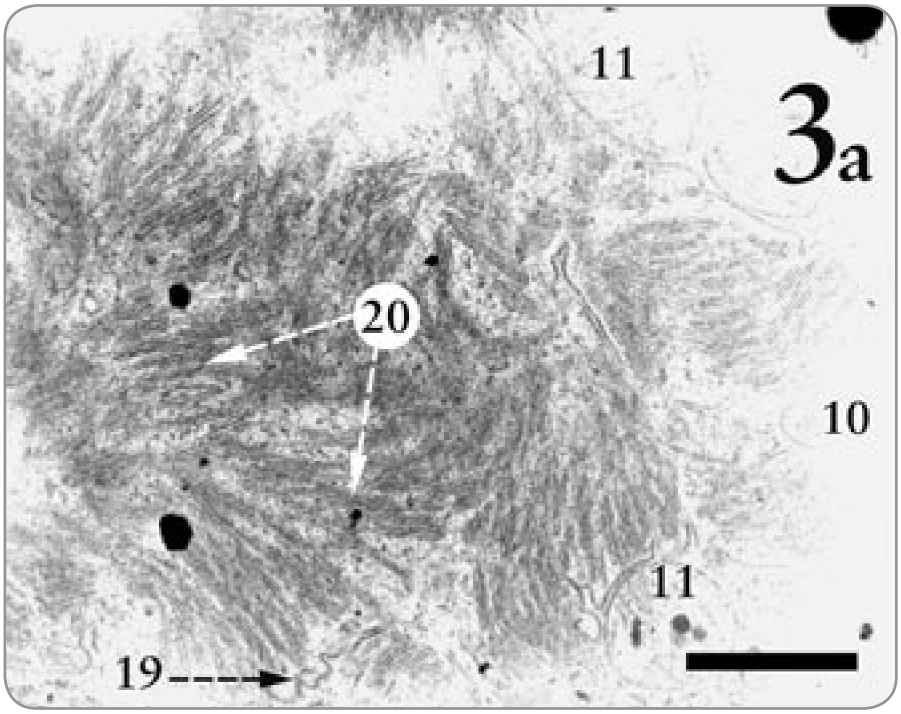

Figure 3a. The chloroplast of a *Trebouxia* algal cell from the algal zone of *Caloplaca sp.* The chloroplast of *Trebouxia* is deeply cleft, forming lobes along its margin (19). Thylacoid membranes of the chloroplast are arranged into grana-like stacks (20), and algal mitochondria (11) are visible in the surrounding cytoplasm (10). The magnification is 14,000X, and the scale bar is 2 micrometers.

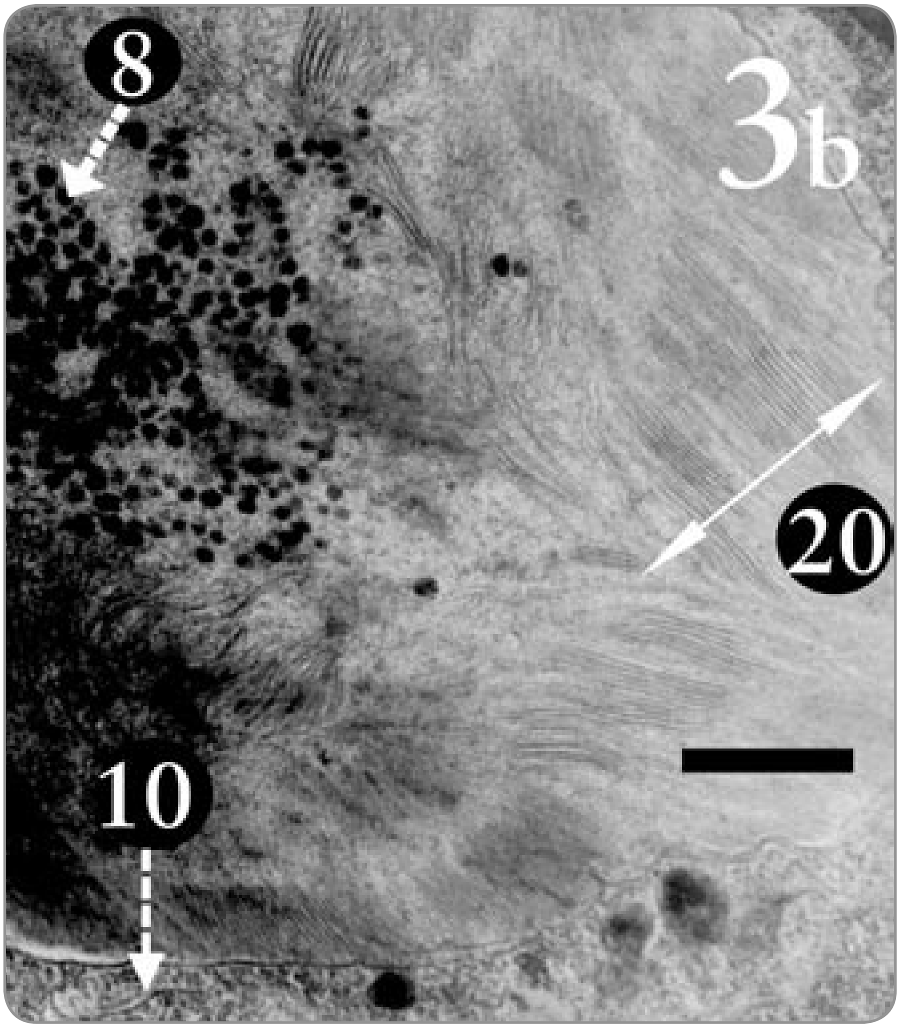

Figure 3b. Another chloroplast of *Trebouxia* sp. from the alga *Caloplaca.* The size bar is 1 micrometers. The grana-like stacks of membranes in the chloroplast (20) can be seen here in several locations as well as the cytoplasm (10) and the pyrenoglobuli (8).

sess an "algal layer," which also contains the lichen fungus. The fungus filaments are called "hyphae" and they make up a "mycelium" network. They are usually subdivided by numerous cross walls into individual sections, which are considered to be "cells," even though the fungus in lichen is often one interconnected body.

The fungus hyphae are in direct contact with the cells of algae (see Figure 1). The algae are equipped to store the energy of light through photosynthesis, and because of the close contact with mycobiont cells, they can supply food to the whole lichen system. Figures 2–8, together with Figure 12, are higher magnification photomicrographs of phycobiont and mycobiont cells found in the algal layer of certain lichens, which grow at the Creation Research Society's Van Andel Creation Research Center (Chino Valley, Arizona). Figures 9–11 are pictures of mycobiont cells from the medulla layer of those lichens.

Trebouxia sp. is the Main Lichen Alga. Figure 2 shows cells of the

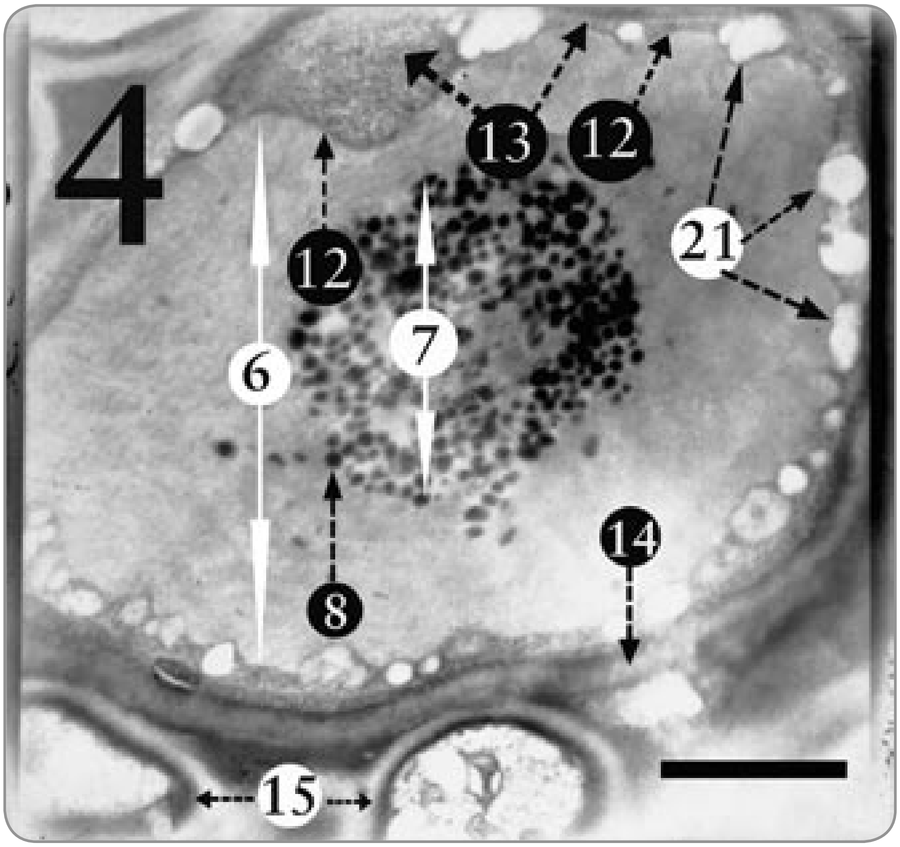

Figure 4. A cell of the phycobiont *Trebouxia sp.* from the algal zone of the lichen *Candelariella sp.* [Note: *Candelariella* is the same yellow orange lichen that we mistakenly called *Candelilaria* in our previous articles (Armitage and Howe 2004; 2006), and correctly identified in Howe and Armitage, 2003]. In addition to the storage layer (13) located just outside the plasmalemma (12), many white storage areas can be observed (21) at the outer edge of the cytoplasm. Pyrenoglobuli (8), which store lipids, are also present in the pyrenoid of the chloroplast. At some locations several pyrenoglobuli are arranged in an orderly line because of their attachment to the thylacoid membranes of the pyrenoid. Numbers for other subcellular particles are as on the previous figures, (6) chloroplast, (7) pyrenoid, and (14) cell wall. Two mycobiont cells (15) are closely appressed to the alga. The three different storage systems seen here enable lichens to thrive despite long periods of unfavorable climate. The magnification is 10,000X, and the scale bar is 6 micrometers.

green alga *Trebouxia sp.* found together with fungal cells in the lichen *Caloplaca sp.* Sections of the *Trebouxia* phycobiont also can be seen in Figures 3–8 and Figure 12. *Trebouxia* is the algal genus present in the majority of lichen species worldwide. Ahmadjian (2001) has recognized about 30 different species in the algal genus *Trebouxia.*

Photosynthesis and Storage Occur in the Chloroplasts of *Trebouxia*

Trebouxia chloroplasts are visible in Figures 2–8, where they are labeled "6." *Trebouxia* has a single, gigantic chloroplast surrounded by a narrow layer of cytoplasm (see Peveling, 1973, p. 149). Inside and weaving throughout the chloroplast are many membranes known as thylacoids. In various algae, these thylacoids are stacked one upon another, forming disk-shaped complexes called *grana* (singular *granum*). Fisher and Lang (1971b) noted that in lichen algae the chloroplast membranes are often stacked this way. But Peveling (1973) reported that the usual stacking of thylacoids was absent in most species of *Trebouxia.* Nonetheless, she did find grana present in the *Trebouxia* phycobionts of *Caloplaca.* The *Trebouxia* cell from the lichen *Caloplaca* (seen as number 20 in our Figures 3a and 3b) likewise has grana-like stacks of thylacoid membranes.

Attached to the many membranes of the chloroplast is an incomprehensibly intricate assemblage of enzymes, carriers, and chlorophyll molecules, by which solar energy is transduced effectively, becoming the chemical bond energy of sugars and other photosynthates (organic molecules produced in photosynthesis). While converting carbon dioxide into sugar during photosynthesis, lichens likewise release generous quantities of oxygen gas into the atmosphere as a by-product. Though not to be reviewed in the paper, the complex details of photosynthesis provide firm evidence favoring intelligent design.

Some lichens are large, but most are small. Because of their widespread global distribution, lichens yield a substantial share of the world's photosynthate. This is reminiscent of God's challenging words in Zechariah 4:10 to the Israelites as they were rebuilding their temple: "Who hath despised the day of small things?" (KJV).

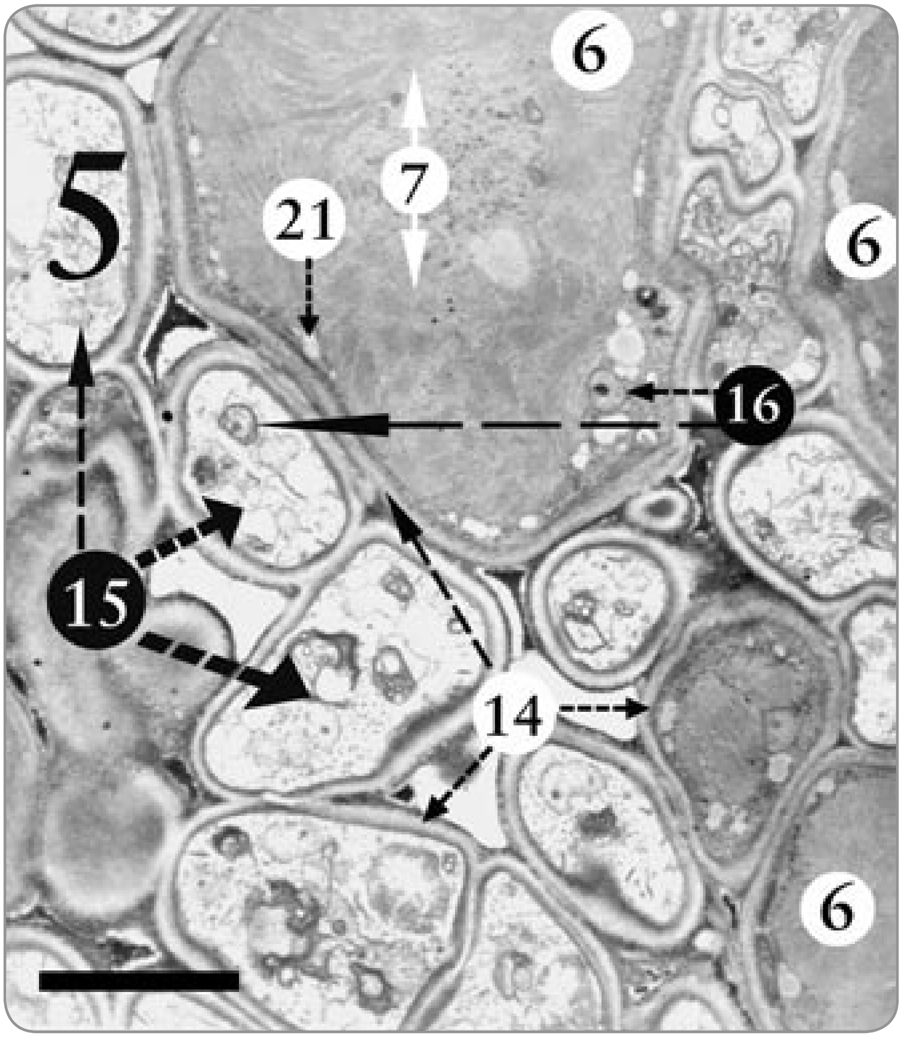

Figure 5. A *Trebouxia sp.* phycobiont cell surrounded by many fungal cells (15) in the algal zone of *Candelariella sp*. In this one section, at least 10 fungal cells are seen in close contact with the one algal cell, upper center, where one whole cell and parts of two others are visible (6). Nuclei with nucleoli are evident in various algal and fungal cells (16). Nucleoli store and transport messenger RNA molecules, which in turn encode for the production of proteins. The magnification is 8,000 X, and the scale bar is 10 micrometers.

Within the chloroplast of *Trebouxia* is a large central region called the pyrenoid (see number "7" on Figures 2, 4, 5, and 8). Pyrenoids contain proteins and lipids, and they are likewise centers for starch synthesis. The pyrenoid is a region where membranes are present, but are not as numerous as elsewhere in the chloroplast (see Fisher and Lang, 1971b, p. 156).

Pyrenoids occur in many other algae besides *Trebouxia* and even in the chloroplasts of *Anthoceros*, a diminutive, mosslike plant called the "hornwort" (Vaughn et al., 1990). Hornworts are placed in the Plantae, the kingdom of "true plants," while green algae such as *Trebouxia* are assigned to an entirely different kingdom, the Prokaryotae, which includes various divisions of algae. The presence of pyrenoids in these two widely separated taxa (hornworts and green algae) has not been accounted for by evolution theorists.

In the pyrenoids of various algae and the hornwort plants is found an important enzyme directly involved in the photosynthetic fixation of carbon dioxide: ribulose-l,5-biphosphate carboxylase/oxygenase, known as *Rubisco* (Borkhsenious et al., 1998). Rubisco also occurs in certain hornworts that have no pyrenoid and in higher plants, which likewise do not possess pyrenoids. The pyrenoids contained in *Trebouxia* algae and in hornwort plants also possess an important carbon-concentrating mechanism by which the carbon dioxide concentration in the cell is enhanced and the production of photosynthates is thereby increased (Smith and Griffiths, 1996).

These and other striking similarities between organisms that are widely separated in taxonomy (green algae and hornworts) deserve further attention in origins discussions. Some evolution theorists hold that higher plants developed through a green algal stage and then to a liverwort-like ancestral form. The hornworts are not considered to be in the direct line of descent proposed from green algae to higher plants but are thought to be a side branch. And yet it

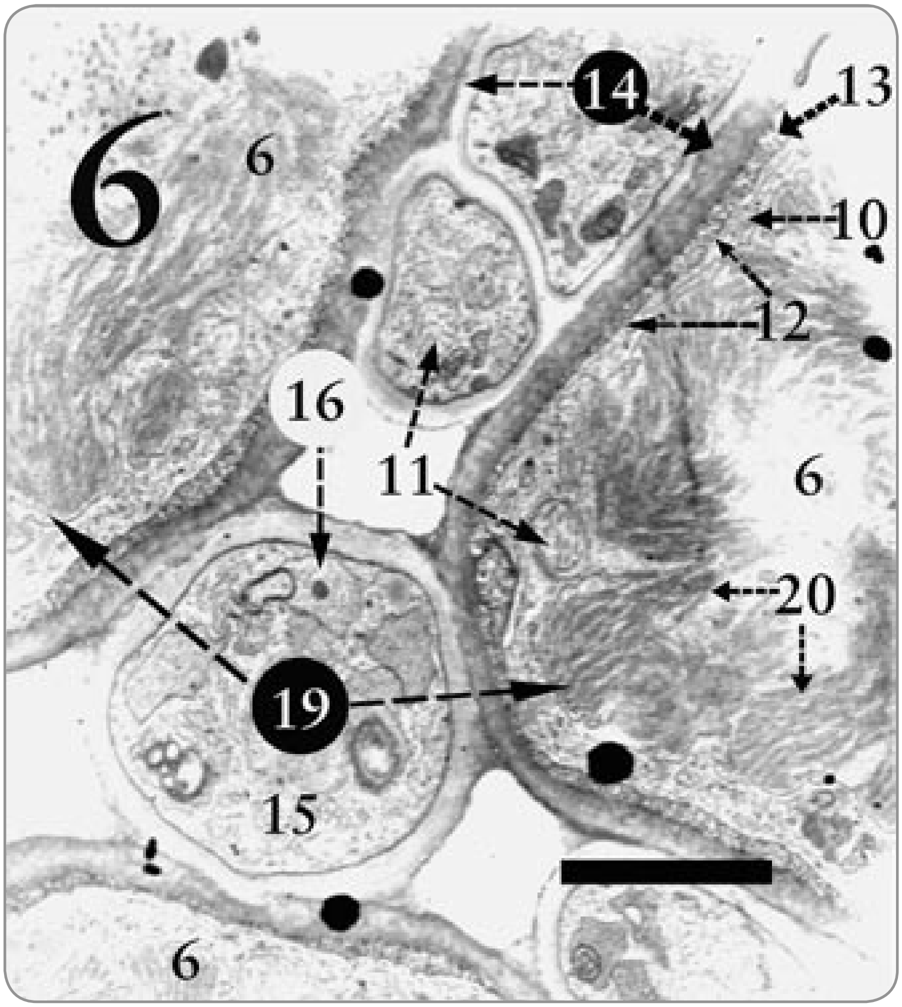

Figure 6. Three *Trebouxia* phycobiont cells in close contact with four fungal cells. Thylacoid membranes (20) can be seen here in the lichen *Caloplaca sp.* Some of the features labeled and identified in previous figures are numbered here as well. Magnification is 11,000 X, and the scale bar is 5 micrometers.

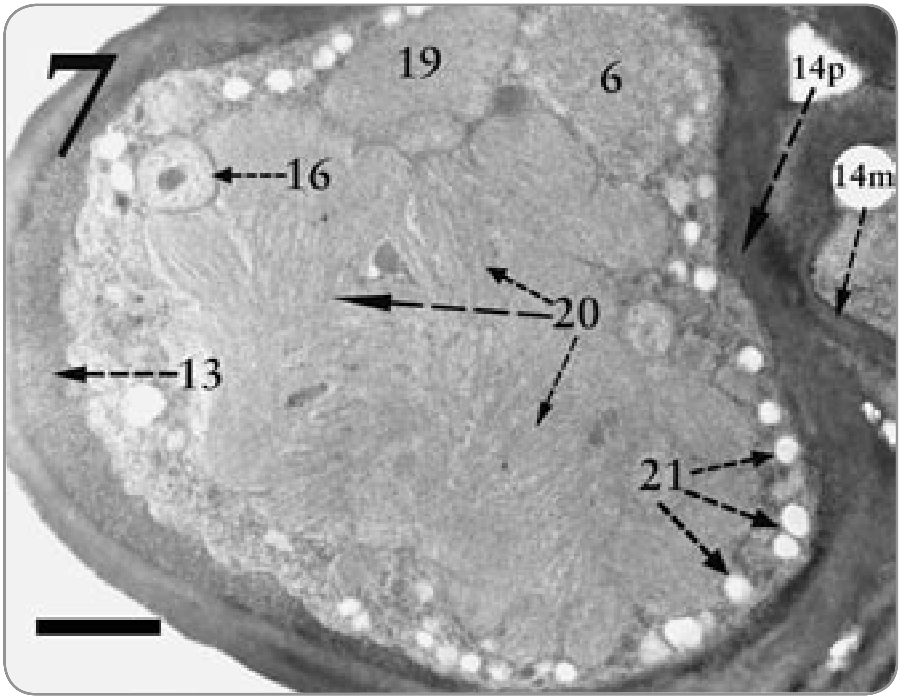

Figure 7. *Trebouxia* phycobiont cell from the algal zone of the lichen *Xanthoparmelia sp.* The following features can be easily distinguished: white storage regions in the cytoplasm (21), storage layer between the plasmalemma and the cell wall (13), a lobe of the large chloroplast (19), nucleus and nucleolus of the *Trebouxia* cell (16), cell wall of the mycobiont (14m), cell wall of the phycobiont (14p), and the stacks of thylacoid membranes (20). Note above, center, the relatively thin cell walls the mycobiont hypha has here in the algal zone of this lichen and compare to the thick walls it produced in the medulla tissue of the same lichen species—*Xanthoparmelia* (see caption of Figure 10). These differences enable the fungus to receive photosynthate from nearby algal cells, whereas in the medulla the thicker walls supply support (see Armitage and Howe, 2006, pp. 258, 261). The magnification is 12,000X, and the scale bar is 4 micrometers.

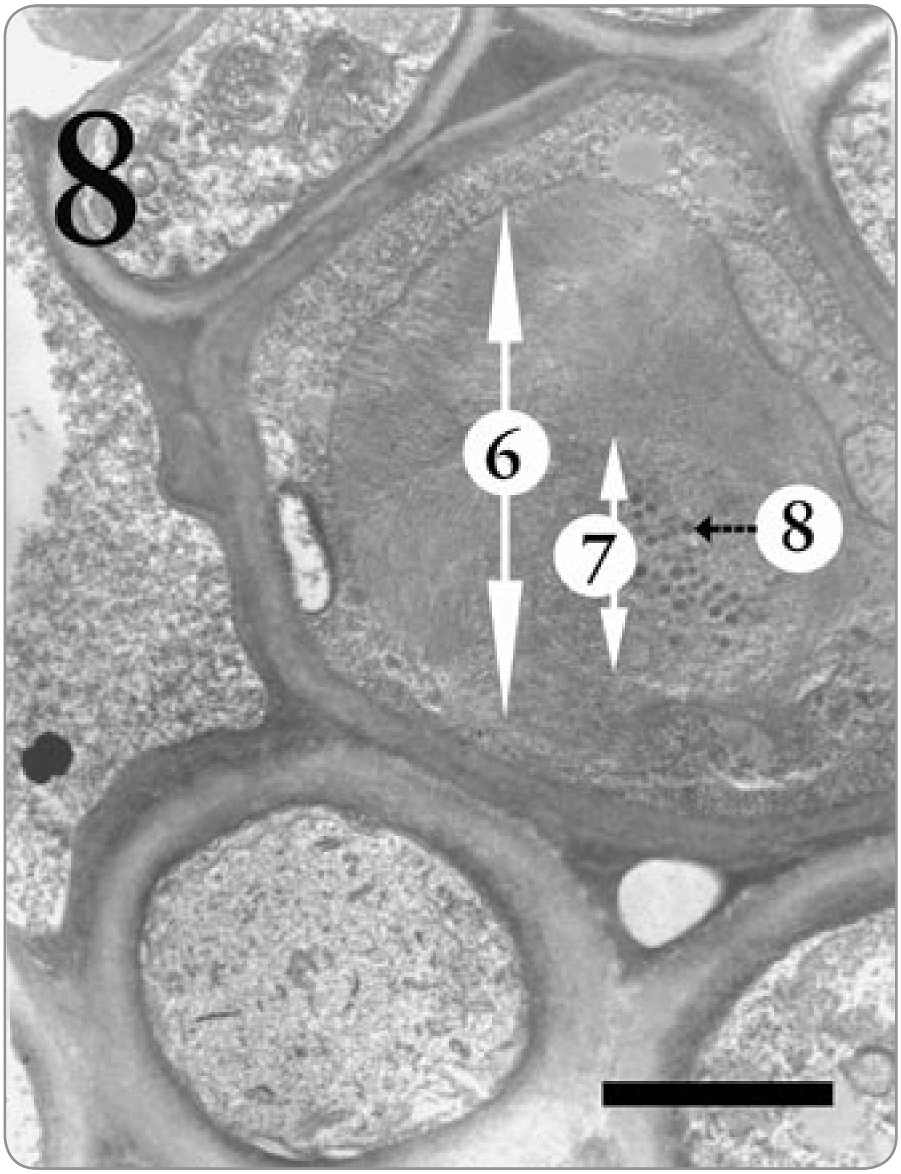

Figure 8. A cell of the green alga *Trebouxia* from the algal zone of the lichen *Candelariella sp.* Pyrenoglobuli (8) are visible, attached in an orderly fashion to the thylacoid membranes of the pyrenoid (7). Pyrenoglobuli contain energy-rich lipids and may perform other important tasks, such as supplying water. Magnification is 11,000 X, and scale bar is 5 micrometers.

is the hornworts, not the liverworts, that possess pyrenoids found in the supposed green algal "ancestors." This puzzling fact presents difficulty for proposed schemes for the evolutionary descent of higher plants. It would be more in line with evolution theories if the chloroplasts of liverworts, not hornworts, possessed a pyrenoid.

What Are the Pyrenoglobuli?

The numerous small dark (electron-dense) circular objects visible in the pyrenoid of *Trebouxia* cells are called *pyrenoglobuli* (singular *pyrenoglobule*) and are labeled with a number "8" on Figures 2, 3b, 4, and 8. Another name for them historically was *osmophilic globules*. Several tests indicated pyrenoglobuli are lipid-rich storage deposits (Jacobs and Ahmadjian, 1969; Ahmadjian, 2001; Fisher and Lang, 1971a). These lipids may "help lichens survive extreme drying" (Egan, 2006).

The pyrenoglobuli are associated with and adjacent to the thylacoid membranes (Fisher and Lang, 1971a), along which they are positioned in a regular pattern, opposite one another (Fisher and Lang, 1971b; Peveling 1976; Brown and Wilson, 1968). The orderly arrangement of pyrenoglobuli, which is caused by this patterned attachment to thylacoids, can be seen labeled "8" at certain locations in our Figure 8.

Pyrenoglobuli are present in the chloroplasts of algae from "most algal classes" (Peveling, 1976, p. 18). Pyrenoglobuli are not limited to *Trebouxia* and have been observed in other photobionts and in free-living algae, as Ahmadjian (1993) pointed out. Ahmadjian (1993) also presented the following list of organisms that have pyrenoids with pyrenoglobuli: the alga *Stichococcus* (both in lichens and living free), zoochlorellae (algae living inside marine animal cells), some species of the alga *Chlorella*, some marine algae, and the hornwort plants.

Plastoglobuli, objects that are similar to pyrenoglobuli, have been observed in the stroma (spaces between the grana) of chloroplasts in angiosperms (flowering plants) such as onions, spinach, and *Tradescantia* (Lichtenthaler, 1968). Pyrenoglobuli and these very similar plastoglobuli are widespread in phycobionts, free-living algae, and plants. Although plastoglobuli were at first assumed to be unique evolutionary productions found only in phycobionts, this evolution-related error was corrected.

There is no absolute certainty concerning the functions of pyrenoglobuli in lichens, but they probably serve as storage centers for lipids and they likely yield supplies of energy and water for the mycobionts (Peveling, 1973; Brown and Wilson, 1968). Secondary carotinoid pigments have been found stored in the pyrenoglobuli (Tschermak-Woess, 1989). Based on microchemical and photographic data, several other functions have been proposed for pyrenoglobuli, including "protection of algae from radiation" (Jacobs and Ahmadjian, 1969, p. 238) and helping in the development of lamellae (thylacoids) for the chloroplasts (Brown and Wilson, 1968).

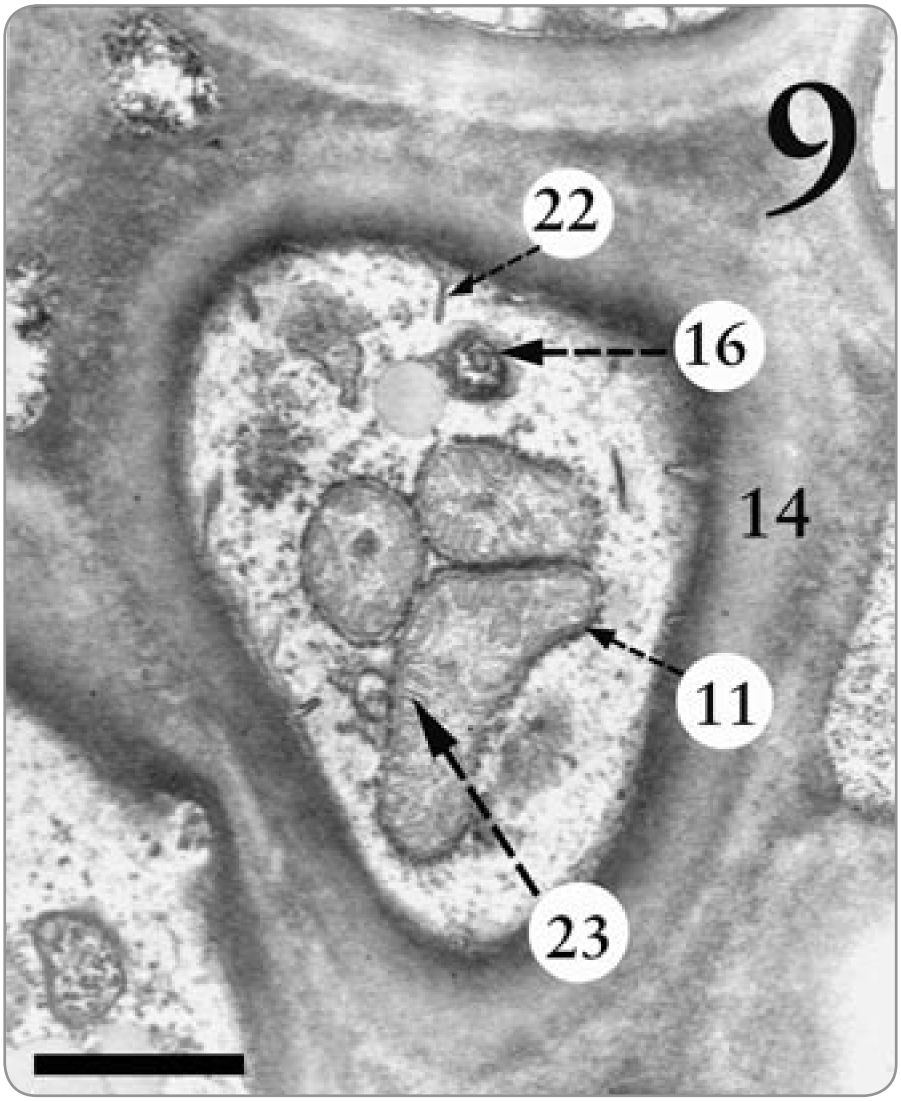

Figure 9. A cell of the mycobiont of *Candelariella* sp. Invaginations of the plasmalemma (22) greatly increase the membrane surface area, thus fostering added contact necessary for various functions. In the center of the cell are three mitochondria (11). Folds of the mitochondrial inner membrane (23) contain a host of enzymes required for the respiratory synthesis of ATP, which is sometimes called the high energy "currency" of the cell. Several other items labeled in previous figures are numbered here as well. Magnification is at 14,000X, and the scale bar is 2 micrometers.

The Synthesis of Starch also Occurs in *Trebouxia* Chloroplasts

Starch is a polymer containing many interconnected glucose sugar units. In algae, the pyrenoid is the center for the synthesis of starch. In the pyrenoids of *Trebouxia*, however, starch is produced normally only when the lichen is living in moist conditions. By way of contrast, the synthesis of lipids in the pyrenoglobuli of *Trebouxia* occurs under both moist and dry circumstances (see Jacobs and Ahmadjian, 1969, p. 238).

When starch is manufactured in the chloroplast, it collects as visible droplets, which move to the edge of the

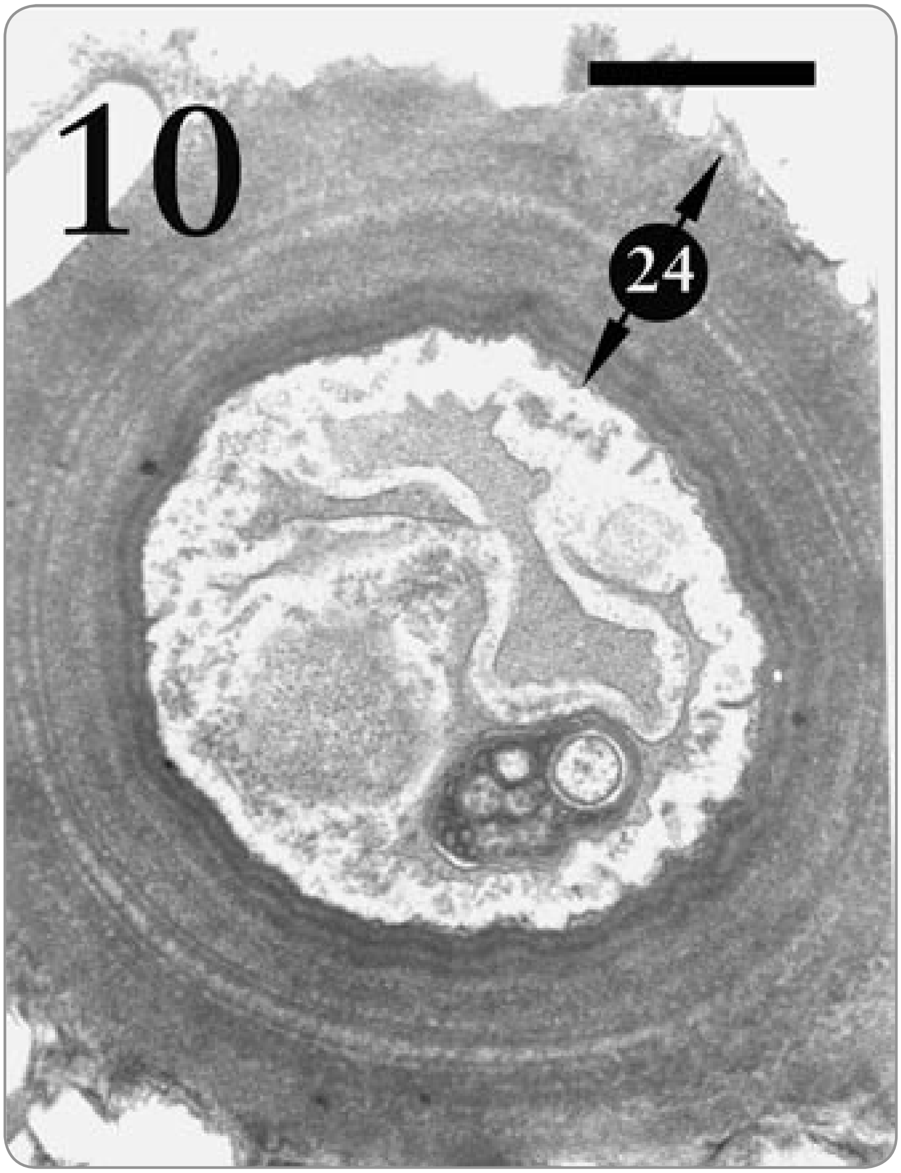

Figure 10. Fungus cell from the medulla region of *Xanthoparmelia sp*. It is quite advantageous for lichen fungal cells in the medulla tissue to possess thick walls (24) where support is required (Armitage and Howe, 2006, pp. 258, 260). The same fungus species makes much thinner cell walls in the algal zone (see Figure 7, number "14" at the top) where absorption of photosynthetic products is a priority. Magnification 15,000X, scale bar 1 micrometer.

chloroplast and are found in the stroma. Such white starch reserves have been photographed by other workers but are not seen in our figures.

Is Starch Storage an "Ancestral Trait" in *Trebouxia*?

Jacobs and Ahmadjian (1969) postulated that *Trebouxia* evolved from a different green algal ancestor. Accordingly, they speculated that *Trebouxia*'s ability to store starch was an "ancestral" trait, which persisted after having been somewhat replaced by the lipid storage mechanism in the pyrenoglobuli (Jacobs and Ahmadjian, 1969, p. 238). But one might theorize instead that starch and lipid storage systems are simply two different alternatives, each designed to enable *Trebouxia* to cache photosynthate under diverse ecological regimes. In fact, Jacobs and Ahmadjian (1969) penned a very "design friendly" remark along that theme by stating that:

> a better way of viewing this is that lipids present in the pyrenoglobuli represent a type of storage product that is more suitable to the lichen symbiosis. In their natural habitats, lichens have only a few hours during the day with an adequate water balance for metabolism…Lipids would represent a product which would give the greatest amount of energy in the shortest possible time. (p. 238)

Although they embraced a different origins model than creation, their statement here would fit well with a design scenario wherein the Creator endowed *Trebouxia* with starch storage for moist circumstances and a lipid-pyrenoglobuli program for periods of low moisture. Starch synthesis is thus a useful secondary system and not an "ancestral trait."

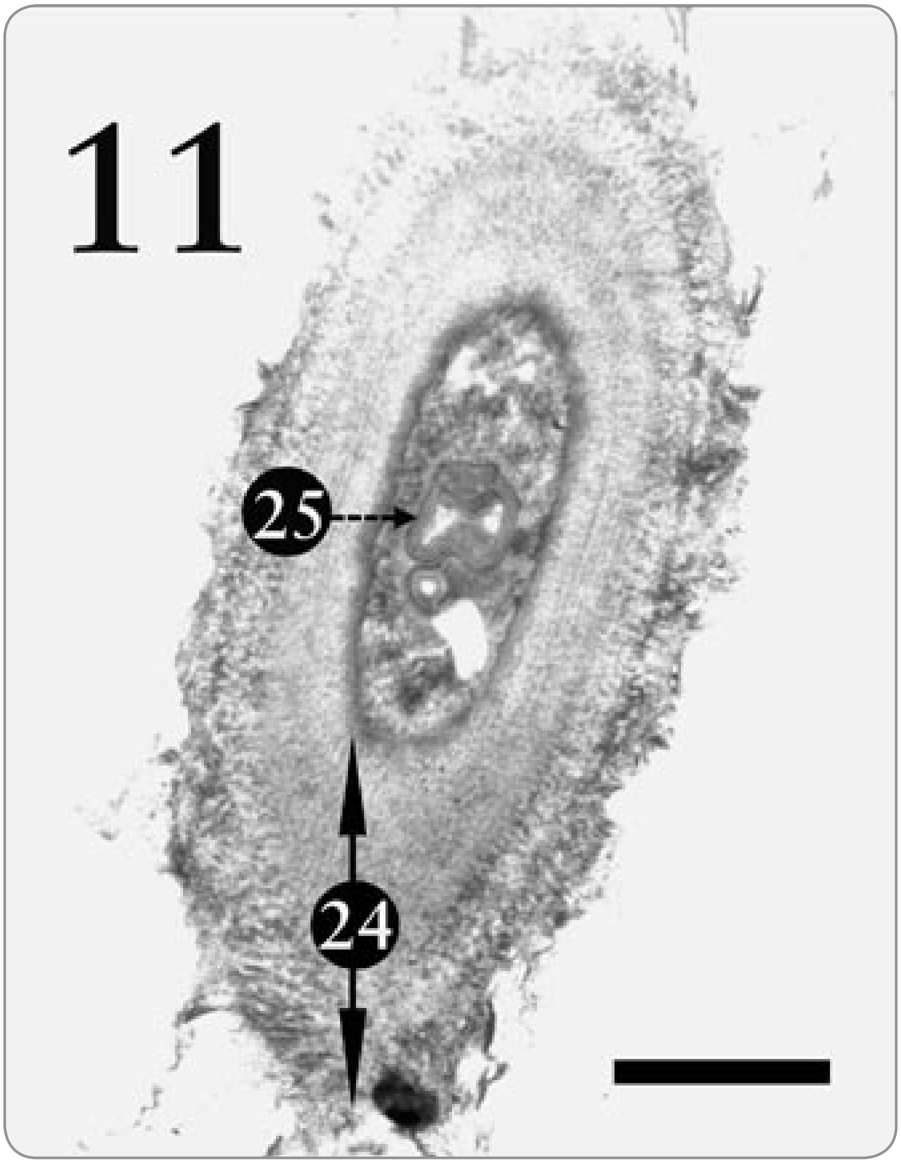

Figure 11. A cell from the mycobiont in the medulla tissue of the same lichen as the previous figure, *Xanthoparmelia sp*. In the medulla, the lichen fungus ordinarily has a thick, multilayered cell wall (24), enabling the medulla to supply support inside the lichen. A large structure seen here and a smaller one too (25) resemble the myelin-like bodies photographed by Peveling (1973, p. 158) and by Jacobs and Ahmadjian (1969). Myelin-like bodies will be discussed in the forthcoming second part of this article. Note its several layers, which resemble a myelin sheath seen in animal neurons. The magnification here is 12,000X with a scale bar of 2 micrometers.

Sucrose Synthesis—Is it Ancestral or Alternate to Ribitol Production?

In its normal growth as a lichen photobiont, the alga *Trebouxia* manufactures the sugar-alcohol called ribitol, which moves into the adjacent fungal cells (Jacobs and Ahmadjian, 1969). When cultured axenically (by themselves), however, *Trebouxia* cells yield sucrose, not ribitol, as a photosynthate. The fabrication of sucrose or ribitol may be design alternatives. It is merely an evolutionary assumption that the ability to synthesize ribitol arose after the origin of sucrose production or that sucrose synthesis is somehow an "evolutionary vestige."

Lichen Algae and Fungi Possess Cytoplasm

The cytoplasm seen in both the alga and the fungus is not an unstructured matrix but "manifests internal order and numerous particulate bodies" (Howe, 1966, p. 106). It is designated as number "10" in Figure 2, 3b, and various other figures. Crossing the cytoplasm transversely is a finely structured, interweaving network of membranes, known as the endoplasmic reticulum, which holds myriads of beadlike ribosomes on its surface. They operate as miniature "forges," where specific proteins are manufactured in accordance to "plans" that come in the form of messenger ribonucleic acid (mRNA) molecules that have been copied from the nuclear DNA. The origin of these many integrated cytoplasmic systems necessary for protein synthesis lacks an adequate evolutionary explanation.

Much larger than ribosomes are mitochondria, which are visible in both the mycobiont and the phycobiont cytoplasm of Figures 2 and 9, and also in several other figures where they are labeled "11." The mitochondria contain involved sequences of enzymes ingeniously arranged along a much-folded inner membrane (Figure 9, number "23"). Through a process called cellular respiration, this enzymatic array is involved in transforming the relatively low chemical bond energies of fuel molecules like glucose into the high-energy phosphate bonds of adenosine triphosphate (ATP). The high energy of the resulting ATP molecules is essential for empowering many endothermic chemical reactions involved in cellular repair, reproduction, and the synthesis of cytoplasmic polymers such as proteins.

Some researchers argue that mitochondria are bacteria that once invaded other living cells. Smith and Brown (1985) provided evidence that mitochondria were instead created as organelles for each separate living kind. The dynamically complex series of coordinated mitochondrial macromolecules, each depending on the other for proper functioning of the cytoplasm, supports rapid creation.

The cytoplasm is surrounded by a cytoplasmic membrane, which is called the *plasmalemma*, a labyrinthine barrier controlling the movement of chemical molecules into and out of the cell. The plasmalemma is visible in many of our figures as number "12" (e.g. Figure 2). It has the "mysterious function of allowing certain chemical substances free passage, while maintaining a closed-door policy to other materials" (Howe, 1966, p. 106). The intricate details of membrane structure and physiology, which command the attention of hundreds of researchers at numerous laboratories worldwide, fit with an intelligent design model.

The Invaginations of the Mycobiont Plasmalemma Render Important Service

The invaginations of the fungal plasmalemmae are seen in Figure 9, number "22." The plasmalemma of the phycobionts, on the other hand, is comparatively smooth. Smith (1973, p. 14) reported that the mycobiont plasmalemma convolutions generally occur where the fungus touches its algal partner (see also Peveling, 1973, p. 159). The invaginations provide an increased protoplast surface allowing high metabolic activity, and they indicate an "uptake of metabolic products" (Peveling, 1976, p. 23). Peveling thought they were an "adaptation," promoting an exchange between symbionts (1973, p. 159). Her use of the term *adaptation* here would fit with the intelligent design view if one assumes that the Creator directly generated such "adaptations." While avoiding the word *adaptation*, Brown and Wilson (1968) nevertheless made this same point: "The highly invaginated and tubular plasmalemma of the fungus points to a specialized molecular basis for exchange of material between the lichen components" (p. 239).

A Storage Zone Lies Directly outside the Cytoplasm of *Trebouxia*

On the exterior of the plasmalemma, directly touching the cell wall, *Trebouxia* cells have a sizeable storage layer, which can be seen on Figure 2 as item "13." Concerning this layer, Peveling (1976) wrote: "All substances observed between the plasmalemma and the cell wall may be considered as transferred metabolites" (p. 23). Photosynthetic products stored here are able to pass effectively from the photosynthetic algal partner to the fungus cell lying closely adjacent to it. Such ease of transfer is critical to the survival of lichens because the mycobionts depend on the phycobionts for their food supply.

Storage Also Occurs in Droplets Formed inside the *Trebouxia* Plasmalemma

Our photomicrographs (Figures 4, 5, and 7—see items labeled "21") show these white droplets in the algal cytoplasm, as did those of Jacobs and Ahmadjian (1969, see pp. 228–229), who simply called them "storage droplets." An anonymous referee of our paper suggested that perhaps these droplets are "evaginated vesicles transferring dissolved food to the storage layer," a possibility that deserves further investigation.

Thus two kinds of storage are associated with the cytoplasm: (1) a large depository of varying width between the plasmalemma and the algal cell wall, and (2) another system entailing numerous distinct white reservoirs at the edge of the cytoplasm, just inside the plasmalemma. These two cytoplasmic storage mechanisms, together with the reserves of lipid cached in the pyrenoid of the chloroplast and the starch reserves in the chloroplast stroma, encompass a large amount of reserve metabolic substrate. Workers who adopt the design view of origins would see this manifold storage program as an intelligent "overdesign," enabling lichens to endure adverse environmental conditions.

Nuclei and Nucleoli Are Present in the Phycobiont and the Mycobiont Cells

The nucleus in *Trebouxia* cells is seen clearly as "16" in Figures 5 and 7. A nucleolus is usually evident inside the algal nucleus. The chromosomes of the nucleus hold the DNA (genes), which control heritable characteristics. Nucleoli are repositories for mRNA molecules, which are produced from the DNA molecules and are then conveyed to the cytoplasm, where they govern protein manufacture.

Nuclei of the mycobiont fungi are visible in Figures 2, 6, and 9 as number "16." Concerning their size, Hale (1961, p. 7) wrote that "the nucleus [of the mycobiont] is exceedingly small, as is usual with the fungi." The haploid chromosome number (base number of different kinds of chromosomes) in the nucleus of fungi varies between 2 and 8, depending on the species.

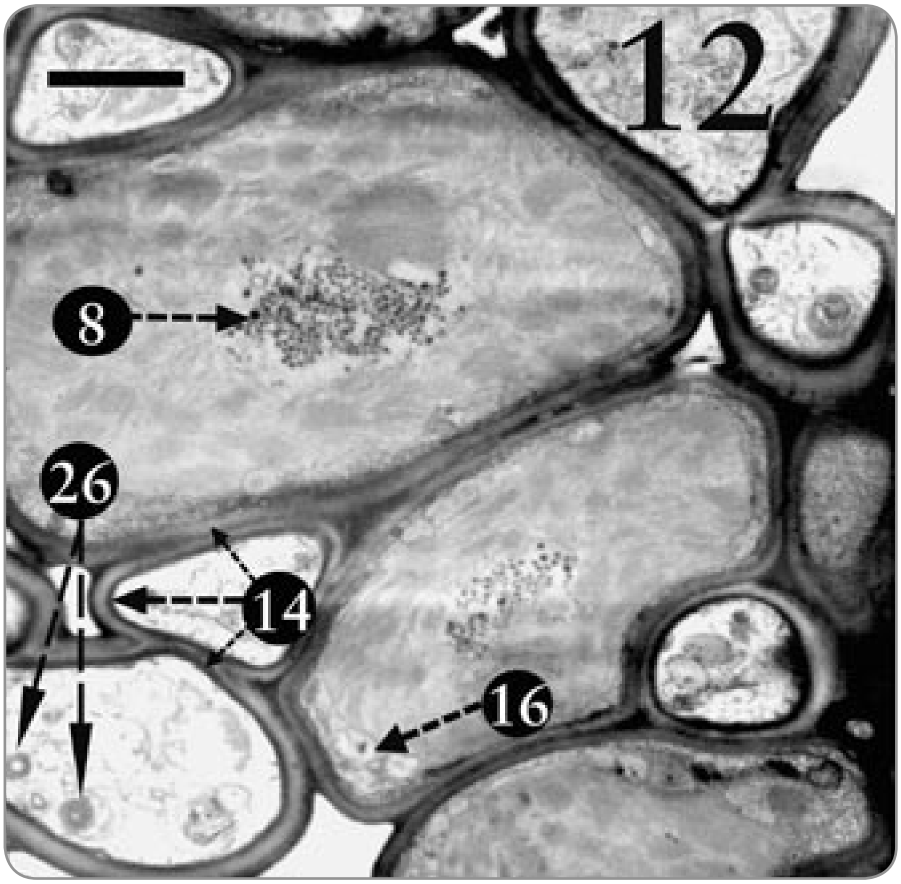

Figure 12. Both mycobiont and phycobiont cells from the algal zone of *Candelariella sp.*

Concentric bodies, often found in mycobiont cells, are visible (26) in the fungus cell, lower left. Present in both mycobionts and free-living fungi, concentric bodies evidently did not originate in mycobionts as a result of symbiosis, as evolutionists once thought. Various organelles from other figures are labeled and numbered here as previously: pyrenoglobuli (8), cell walls (14), and nucleus (16). Magnification is 6,000 X, while the scale bar is 15 micrometers.

Concentric Bodies Occur in the Cytoplasm of Mycobiont Cells

Concentric bodies have also been historically called *ellipsoidal bodies*. They are found in the cytoplasm of lichen mycobiont cells, where they occur singly or in clusters, and may be surrounded by electron transparent halos. Groups of them lie in a matrix associated with the cell nucleus (Griffiths and Greenwood, 1972). They are small, having an "electron transparent core and two surrounding shells" (Peveling, 1973, p. 159), which have different electron densities (Jacobs and Ahmadjian, 1969, p. 231). Spherical in shape, the concentric bodies appear to possess radially arranged lamellae. With photomicrographs and sketches, Galun (1988a, see pp. 145–147) described the intricate structure of these rings and radial striations found in concentric bodies. They are evident at the lower left of our Figure 12, where we designate them as number "26."

Although the roles played by concentric bodies are not known with certainty, several suggestions have been made. Since they are often located in the proximity of the plasmalemma, they may be involved in membrane synthesis (Jacobs and Ahmadjian, 1969), possibly functioning as a kind of membrane repair kit. Like golgi bodies, they may also function in the movement of protein molecules. Ahmadjian (1993) suggested that they might even be viruses.

In the 1970s, it was reported that concentric bodies had been discovered in 43 species of lichenized fungi and in two species of non-lichenized fungi, as well (Griffiths and Greenwood, 1972; Peveling, 1973). In 1993 Ahmadjian updated this tally, writing that concentric bodies had been identified in the mycobionts of about 100 species of lichens and in 11 different species of non-lichenized fungi. Galun (1988a) also confirmed the presence of concentric bodies in non-lichenized fungi by acknowledging that "the few free living [nonlichenized] fungi which contain concentric bodies are limited to ascomycetes" (p. 145). Classen et al. (2000) found concentric bodies present in a non-lichen ascomycete fungus parasitic on the pollen of the flowering plant *Malva sylvestris.*

In the Lichen Literature, Is Evolution Usually Treated Like a Scientific Theory or Like an Origins Model?

The evolutionary idea that lichens and all life have descended gradually from a common ancestry over vast aeons is often espoused like some sort of religious/philosophical presupposition rather than being handled like a real scientific theory. Even after leading to false conclusions about scientific data, evolutionism is so very plastic that its devotees can quickly modify it to fit the conflicting new information. This demonstrates that evolution is an origins model, not a scientific theory.

An illustration of this point exists in the history of lichenology. Evolutionism was part of a minor error that was corrected. We bring up one of these evolution-based errors, not to criticize the lichenologists involved, but to show the evolutionary basis of their error and to demonstrate that they reversed earlier ideas in order to preserve evolutionism.

Two lichenologists once thought they had shown that concentric bodies are "unique" to mycobiont fungi (Jacobs and Ahmadjian, 1969, p.239). As a result of their early micrographic studies, they believed that concentric bodies are found only in the fungi of lichens (mycobionts) and are absent from non-lichenized fungi. Based on those data and on evolutionism, they suggested that concentric bodies were perhaps produced by evolution in the mycobionts while the condition of symbiosis was also being evolved, an idea that seemed plausible to them, based on their evolution origins model.

In 1972, however, Griffiths and Greenwood reported discovering concentric bodies in two non-lichenized fungi. And, as stated earlier, it is now known that concentric bodies are widely present in non-lichenized fungi; they are not unique evolutionary innovations found only in mycobionts. This evolutionary error was rectified by Ahmadjian (1993, see p. 22). He did not hold evolutionary assumption accountable in any way, however, as he might have done, but simply originated a different evolutionary idea. Nor did he state that evolutionism had been shown to be somewhat inadequate in this situation. Instead, he completely reversed his original explanation, thereby creating a new evolution-based scenario. In this modified view, it was assumed that concentric bodies were probably widely present in the non-symbiotic ancestors of lichen fungi, who passed them on by evolution to their mycobiont descendants (Ahmadjian 1993). His "reversal" illustrates the manner in which evolutionism has little predictive power, frequently serving as just an afterthought that makes it applicable to almost any data. It also demonstrates that evolution is treated as a philosophical presupposition and is thereby considered to be unassailable, even when predictions based upon it turn out to be inaccurate.

It has been said, and we think correctly so, that macroevolution is too plastic to qualify as a "scientific" theory. Scientific theories should be falsifiable, but the evolution theory is easily flexed to accommodate almost any outcome, making it safe from refutation. Renowned philosopher of science, Karl Popper, maintained that evolution is not a scientific theory but is instead a metaphysical proposition, because it cannot be subjected to falsification. His major philosophy, called "Falsificationism," is the idea that "science advances by unjustified, exaggerated guesses followed by unstinting criticism" (Karl Popper web, 2006). Popper recognized that unfalsifiable theories, such as evolution, are somewhat "like the computer programs with no uninstall option that just clog up the computer's precious storage space" (Karl Popper web, 2006).

We agree with Popper's assessment, and it is our personal opinion that the creation model likewise is "unfalsifiable." Therefore, evolution and creation should both be classed as "origins models" and not as "scientific theories" (Armitage and Howe, 2004, pp. 250–251). This is not understood or practiced by many evolution-minded scientists and by many of the judges who have officiated in creation versus evolution court cases over the years. Unfortunately, such people have treated evolution as pure science while characterizing creation as totally "religious."

Conclusion

In forthcoming second part of this article, more cellular details of lichens will be presented. We will also continue to contrast evolution and creation in relationship to the origin of lichen ultrastructure. A close analysis of any living system supplies evidence in support of an origin by design.

Acknowledgments

We are solely responsible for the comments and photographs in this essay, but we acknowledge with gratitude the generous assistance given to us in various ways. The following individuals gave us valuable editorial assistance: Stephen B. Austin, Jerry Bergman, Wayne Frair, Lane Lester, E. Norbert Smith, and two anonymous reviewers. Peg Wesphalen secured many sources for us through interlibrary loan. We are also grateful to Cindy Blandon for arranging the printed version of this paper. We express gratitude to the contributors to the CRS Research Fund and the Van Andel Creation Research Center Fund. Interest from these two endowments has helped finance various phases of our research.

Although disagreeing with the philosophical presuppositions of various lichenologists, we are nonetheless grateful for their detailed studies of God's little lichens. With deep and final appreciation, we respectfully acknowledge the exceedingly skillful handiwork of the Creator, as reflected repeatedly in the ultrastructure of lichens.

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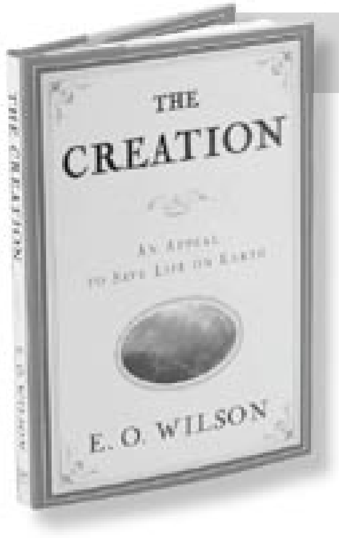

Book Review

The Creation: An Appeal to Save Life on Earth

by Edward O. Wilson

W.W. Norton & Company, New York, 2006, 175 pages, $22.00.

E.O. Wilson is one of the world's best known biologists. Now retired, he was on the faculty at Harvard University for 41 years, specializing in entomology, ants in particular. Wilson has been a leading spokesperson for biological evolution for many years. During his career Wilson published 20 books and more than 400 articles, many of them dealing with evolution.

At the beginning of this book, Wilson acknowledges, "I am a secular humanist. I think existence is what we make of it as individuals" (p. 3). Thus *The Creation* seems a strange title for a book by Wilson. The word "Creation" implies there is a Creator, yet a humanist rejects theism.

It is also strange that *The Creation* is presented as a "Letter to a Southern Baptist Pastor" (p. 3). Wilson grew up as a Southern Baptist in Alabama but he long ago abandoned his faith. The stated purpose of the book is to seek common ground between science, specifically biology, and religion. Wilson seeks to engender support from religious people in the cause of preserving the environment.

The Creation makes it clear that Wilson is an environmental activist. "The Creation - living Nature - is in deep trouble"(p. 4). Wilson sums up this "trouble" by the acronym "HIPPO" (p. 75). H stands for habitat loss (*e.g.*, by deforestation, human exploitation, and climate change). I is for invasive species, *i.e.*, species that are transferred by man to new regions where they disrupt the ecosystem. P is for pollution as from toxic chemicals, waste material, and greenhouse gases. The second P is for human population; Wilson believes there are too many people on earth. O is for overharvesting by man via hunting, fishing, and gathering.

Overall, Wilson advocates a type of radical environmentalism that portends mass extinctions, the depletion of resources, runaway global warming, and a desolate future. All will be lost, the alarmists claim, unless we immediately jump on the bandwagon of sustainability. It is here Wilson makes his overture to people of faith: "If religion and science could be united on the common ground of biological conservation, the problem would be solved" (p. 5). Wilson suggests that three issues must be addressed: "ignorance of the environment, inadequate science education, and the bewildering growth of biology" (p. 13).

Wilson's general solution to the environment's perceived ills is education of the young. Raise children to appreciate science and the living world. Turn citizens into naturalists: People who desire to explore the natural world and to solve environmental problems. The basic idea is that the more people love and understand nature, the more eager they will be to preserve it. In principle this is not a bad approach; there seems to be no conflict between science and religion here.

If Wilson had stopped at this point, he might have reached some common ground with people of faith. But *The Creation* also contains a heavy dose of secular evolutionary thinking. Wilson lists two fundamental laws of biology which he calls the "paramount science" (p. 106). The first law appears reasonable: "all the known properties of life are obedient to the laws of physics and chemistry" (p. 110). It is the second law that raises a warning flag, however: "all biological processes … have evolved by natural selection" (p. 113).

Wilson then spouts the usual pro-evolution verbiage. Biological evolution "is supported by an overwhelming body of interlocking evidence" (p. 166). Design is out: "no positive evidence exists for Intelligent Design," and ID "does not qualify as science" (p. 166). "Biologists are explaining the previously unexplainable - providing evolutionary steps for the autonomous origin of ever more complex systems - at an accelerating rate" (p. 167).

In the end, Wilson's plea for an environmental crisis is not that convincing to me, particularly since his arguments are couched within a secular worldview. Environmental activism is popular these days, but a radical shift to a so-called sustainable lifestyle would cripple the world's economy, severely damage developed countries, weaken core industries, and lead us toward a one-world government.

God calls upon us to be good stewards of His creation. Thus conservation of resources and the development of alternatives is good policy which deserves our support. But I am of the view that the physical earth is not in such deep trouble as activists like Wilson would have us believe. The earth and its lifeforms have survived many changes in the past—some of them catastrophic—and I predict that life will adapt to whatever nature has to bring in the foreseeable future.

The environmental alarmists and secular evolutionists have hijacked science to support their politically correct agenda. The sad thing is, for the most part they are getting away with it. If scientists like Wilson really want to reach "common ground" with religion, they need to be open to ideas including supernatural design in nature and biblical eschatology.

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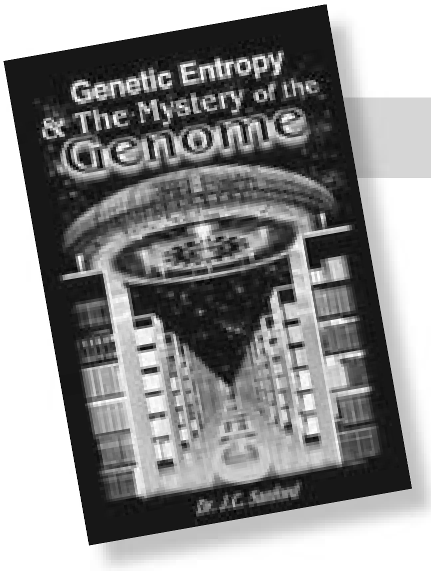

Book Review

Genetic Entropy & The Mystery of the Genome—The Genome Is Degenerating

by John C. Sanford

Ivan Press, Elim Publishing, Lima, NY, 2005, 216 pages, $17.00.

There are many books giving evidence that evolution did not happen, but this book in addition convincingly clarifies why it could not happen. Cornell University Professor Sanford propounds that modern Darwinism is built upon a primary axiom involving random mutation plus natural selection, and he explains the convincing evidence that this popular position is wrong. Darwinian mechanisms are incapable of creating or maintaining necessary genomic information. The human race, for example, has been and is degenerating, heading irreversibly toward extinction. The main message is clear, but readers with backgrounds in biology (especially genetics) and mathematics will understand the issues in much greater depth. Sanford's book should be required reading for all biologists.

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CRSQ

Muscle Evolution Is a Major Problem for Neo-Darwinism: A Review

Jerry Bergman*

Abstract

Muscle has a structure that is irreducibly complex and shows no evidence of progressive evolution when a comparison is made between different animals. The skeletal muscles in a bee are little different in anatomy and function than those in a human. Muscle in all life-forms is so similar that it requires training and a good microscope to tell the difference. It appears reasonable to conclude that organisms in each kind were endowed with their own well-designed muscle tissues.

Introduction

Muscles are critical for animal life. They are used not only to move gross structures, but also to adjust many small living units such as the eyeball. Humans require muscles to lift a book, blink an eye, take a step, curl a finger, throw a ball, or even just to inhale a breath. Muscle tissue is considered so important by researchers that one scientist who discovered how muscle cells function said he worked in this area because it "came closest to the essence of life" (Vogel, 2001, p. 11).

Neo-Darwinists predict that muscle in animals like worms, insects, and mammals should show an ascending sequence of evolutionary "advances." This is not what researchers have found. The study of comparative anatomy has revealed that muscles across the entire animal kingdom differ little in basic design and function, whether we study a bee or a human. Yet they accomplish many diverse tasks, such as humans walking, flies flying, rattlesnakes rattling, and squids shooting black liquids in order to hide in the water. Muscle design in fleas, elephants, and humans is almost identical; it is so close that it requires both a microscope and a trained eye to discern the difference (see Vogel, 2001, pp. ix, 1). Muscle tissue sold as a food is called *meat*. Meat inspectors must employ biochemical testing with antibodies in order to detect efforts to swindle customers by trying to substitute cheaper meat, such as horse meat for cow meat.

Types of Muscle

The four basic types of both vertebrate and invertebrate muscle are: (1) fast skeletal, (2) slow skeletal, (3) cardiac, and (4) smooth (OOta and Saitou, 1999). They can be differentiated by location: *skeletal* muscles are attached primarily to bone and occasionally to the skin, *cardiac* muscle forms the walls of the heart, and *smooth* muscle forms the walls of hollow structures such as the blood vessels, the stomach, and the intestine. The microscopic appearance of skeletal and cardiac muscle is striated, not smooth (Saladin, 1998). Cardiac muscle has a built-in pacemaker to achieve autorhythmicity, and smooth muscle often also utilizes autorhythmicity to function. Skeletal muscle is consciously controlled, while cardiac and smooth muscles are largely controlled by neurotransmitters and hormones. Vogel (2001) concludes that muscle contains the same design in all life:

> The same device powers a microorganism, thirty-thousandths of a millimeter long, that powers a whale, thirty meters (one hundred feet) or a million times longer. Muscles do differ among themselves—red muscle, white muscle, fibrillar muscle, catch

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> muscle—but we mustn't lose sight of the underlying commonality of cross-striated skeletal muscle. In mechanism of action, in speed of action, in force production, in power output, muscles differ less among themselves than do the electric motors that power our home appliances (p. 95).

Furthermore, the "architecture of a given muscle is extremely consistent among individuals of the same species and the same basic architectural principles exist throughout the animal kingdom" (Lieber and Friden, 2000, p. 1647). The function of all muscle can be summarized as follows: nerve stimulation causes it to draw its ends together, or to try to, such as to hold something in one place. Even muscle mitochondria are very similar in invertebrates and vertebrates (Henwood, 1992). This similarity conflicts with the evolutionary concept of neo-Darwinism.

The Anatomy and Physiology of Muscle

About half of a human's weight is muscle mass. The five basic functions of the body's muscle system are: (1) to cause body motion (such as walking), (2) to stabilize the body position (such as standing or sitting), (3) to cause movement of substances within the body (the heart pumps blood, and the smooth muscle contracts to aide movement of food through the intestinal tract), (4) to regulate organ volume (such as moving the contents through a hollow organ), and (5) to function in thermogenesis (muscle contractions generate as much as 85 percent of all body heat). Called an "electrical engine," muscle is a "remarkable engine: soft, wet, and contractible" (Vogel, 2001, p. 18).

All muscle tissue has five characteristics: (1) irritability, the property to respond to stimuli by producing electrical signals called *action potentials* that lead to movement; (2) conductivity, the ability of a cell to propagate action potentials; (3) contractility, the ability of muscles to shorten and thicken to cause movement and do work; (4) extensibility, the ability of the muscle to extend without damaging the tissue; and (5) elasticity, the trait allowing a muscle to return to its original shape after contraction or extension (Seeley et al., 2003).

Skeletal muscles are well supplied with blood vessels for the high level of nutrients they require in order to perform their necessary functions. Blood is needed in order to convey nutrients the muscle cells require to make ATP, to repair the muscle cells, and also to remove the waste products produced by the many chemical reactions that occur in muscle. Interrelations like these between muscles and the blood system illustrate how the body itself, vertebrate or invertebrate, is irreducibly complex. Each of many parts of the body must be present and functional for the body to operate efficiently. This type of "irreducible complex" system is strong evidence of design.

Nervous Control

Muscle control is achieved by electrical-chemical signals. A nerve signal travels along a path separated by a neuromuscular junction called a *synapse*, a term that means "connection." The synapse functions as a switch and usually is located in a region containing a small gap (the synaptic cleft) that separates the two nerve cells. To bridge this gap requires a neurotransmitter to travel from the nerve to the muscle. At the neuromuscular junction, the synapse between the neuron and muscle fibers (the distal part of the axon terminal) expands into a synaptic end bulb that contains many membrane-enclosed sacs called *synaptic vesicles* (see Figure 1). The evolutionary origin of muscle control by such electrochemical signals remains unexplained after decades of research.

The synaptic vesicles contain the neurotransmitter molecules. The neuromuscular junction uses acetylcholine as a neurotransmitter. The other side of the synaptic cleft is the motor end plate, which contains about 30 to 40 million acetylcholine receptors. When a nerve impulse reaches the synaptic end bulb, it triggers the liberation of acetylcholine, which diffuses into the synaptic cleft and binds to the receptor, causing an inrush of sodium ions. The ions change the resting membrane potential, triggering a muscle action potential that travels along the muscle cell plasma membrane, initiating muscle contraction (Seeley et al., 2003). The complexity, and also the simplicity, of this sequence remain unexplained by neo-Darwinism.

Motor nerves deliver the stimulus that causes the muscle cell fibers to contract. The neuron, plus the set of about 150 muscle fibers it stimulates, is called a *motor unit*. All the muscles in a motor unit contract and relax together.

In order to function, muscles require many support structures—the origin of which cannot be explained by neo-Darwinism. Muscle alone is "a semi-solid gel" that requires heavy sheets of connective tissue to function (Vogel, 2001, p. 11). Examples include faciae (from Latin *fascia*, meaning "bandage"), which are sheets of fibrous connective tissue that surround muscles. The first are superficial faciae, which are immediately below the skin and function to provide mechanical protection against trauma and support for nerves and blood vessels that enter and exit the muscles. The second type, deep faciae, is a dense irregular connective tissue that surrounds muscles, separating them into functional groups and allowing their free movement and support for nerves, blood vessels, and lymphatic vessels (Saladin, 1998).

Tendons (from *tendere*, "to stretch out") are cords of dense connective tissue that attach muscle to the bone periosteum. The aponeurosis (*apo*, "from," and *neuron*, "a tendon") is a fibrous sheetlike membrane resembling

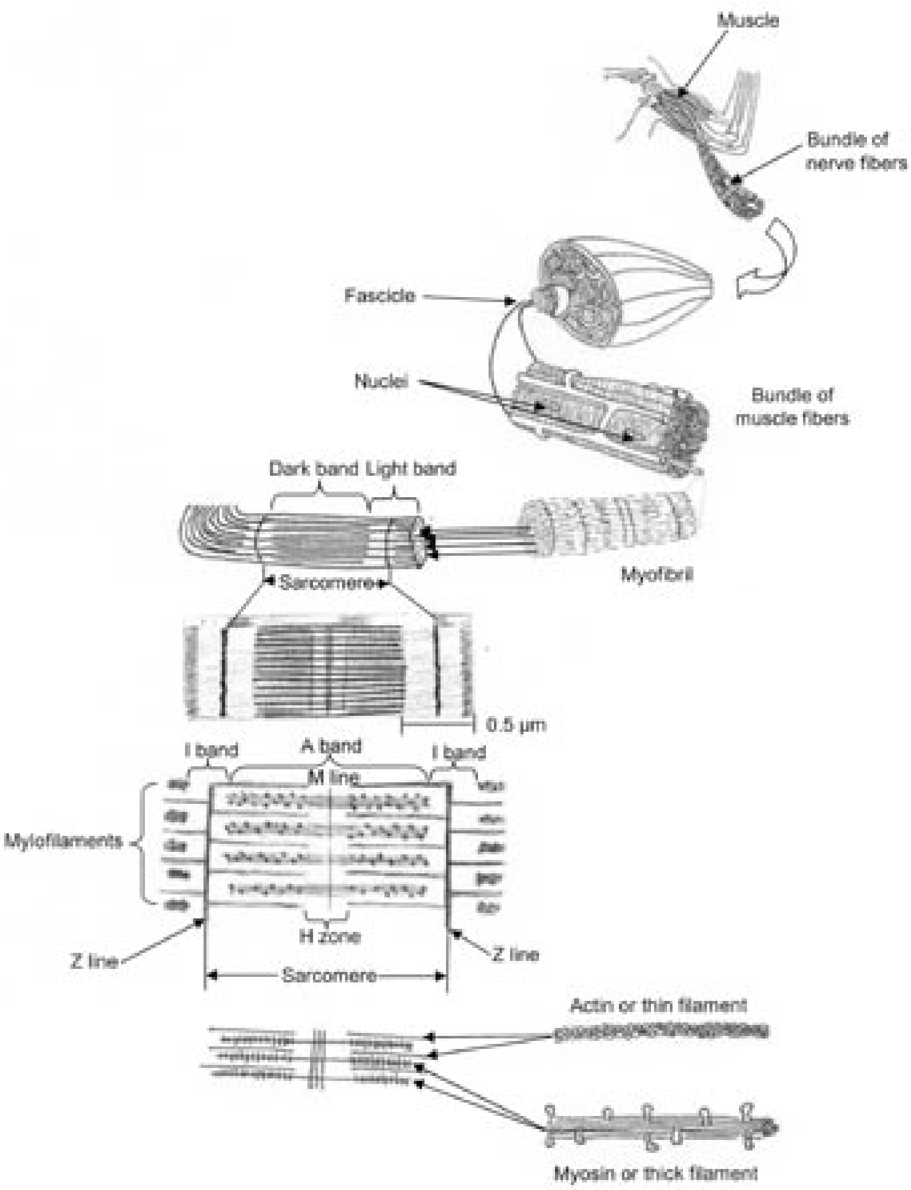

Figure 1. The neuromuscular system showing the gross and microanatomy of a muscle. The muscle in the arm consists of a bundle of nerve and muscle fibers. Each muscle fiber consists of a single cell with several nuclei. The muscle fibers inside the muscle cell are called *myofibrils* and are bundled in sets connected and separated by various structures such as fascicles. A bundle of muscle fibers consist of many myofibrils, each of which contains mylofilaments and actin. Actin strands are also called *thin filaments*. The thin and thick components interdigitate, forming light bands and dark bands when viewed under a microscope. When enlarged farther, various distinct regions can be seen, including I and A bands, M lines, the H zone, and the Z line. The bottom of the illustration shows the mechanism of muscle contraction powered by ATP. Essentially, the actin and myosin move together similar to sliding one's fingers together to shorten the space between one's hands, a process called *interdigitation*. (Figure adapted from Saladin, 1998, and Seeley et al., 2003).

a flattened tendon. It is a sheet of connective tissue that extends as a *broad flat layer over the muscle*, attaching it to the covering of a bone muscle or skin.

Skeletal Muscle Structure

A microscopic examination of the skeletal muscle structure reveals hundreds or thousands of long cells called *muscle fibers* or *myofibers* that lie parallel to each other. They range from 10 to 100 micrometers in diameter. The plasma membrane of the muscle cell is the *sarcolemma* (*sarco* means "flesh," and *lemma* means "sheath"). It surrounds the muscle fiber cytoplasm called the *sarcoplasm*. During embryonic development a single muscle arises from the fusion of many smaller cells called *myoblasts*. For this reason each muscle fiber has many nuclei located at the cell's periphery, conveniently out of the way of the contractile elements. The mitochondria are oxidative organelles that lie in rows throughout the muscle fibers, a functional arrangement that allows muscle proteins to use the large amounts of adenosine triphosphate (ATP) required for contraction (see Figure 1 for a diagram of the basic parts and operation of muscle). Critically important are the myofibrils (the skeletal muscle's contractile elements) that contain both thin and thick filaments (Seeley et al., 2003). These cellular anatomical details support the origin of muscle cells by design, not gradual evolution by a step-wise method. One reason is that muscle will not function unless, and until, all of the parts shown in the diagram are present. Without the thin filament, the thick filaments, the nucleus, the myofibril, and many other parts, it will not function.

Muscle contraction is caused by an interdigitating sliding filament system. Although the exact mechanism involved in muscle contraction remains elusive, it is known that it is very complex, requiring scores of different proteins—at least six types including titan are involved in the sliding mechanism alone (see Vogel, 2001, p. 20). The myosin heads pull on the thin filaments, causing them to slide towards the H zone located in the center of the thick filaments. When maximally contracted, the thin filaments overlap, producing muscle shortening.

An increase in calcium ion concentration in the sarcoplasm initiates the filament movement, and, conversely, a decrease in calcium stops movement. Active transport pumps move calcium from the sarcoplasm into the sarcoplasmic reticulum organelle. Calcium released from the sarcoplasmic reticulum combines with troponin, causing troponin to change shape, which moves the troponin-tropomyosin complex away from the myosin-binding sites on actin.

The Z-discs are endplates that connect adjacent muscle cells. Vogel (2001) called them "complicated structures made up of at least four other kinds of protein" (p. 20). The high-energy yielding phosphate compound ATP provides most of the energy required for muscle contraction. When a muscle is relaxed, ATP attaches to specific ATP binding sites on the myosin cross bridges located on the myosin projections. On the myosin head there exists a section that acts as ATPase, an enzyme that uses hydrolysis to split ATP into ADP plus a phosphate group.

A result is the transfer of energy from ATP to the myosin head, energizing the myosin cross bridges. When the calcium level rises to a certain level in the sarcoplasm, the tropomyosin moves away from its blocking position, causing the activated myosin heads to spontaneously bind to the myosin binding sites on actin. This produces the power contraction stroke, causing the myosin heads to swivel toward the center of the sarcomere, similar to the way boat oars move during rowing. As the myosin heads swivel, they release ADP to be recycled. The interrelation of parts required in this system is another example of irreducible complexity that requires design.

Muscle fibers relax after contraction because acetylcholine is rapidly broken down by acetylcholinesterase. This ends the generation of the muscle action potential and causes the calcium release channels in the sarcoplasmic reticulum membrane to close. In addition, a second set of calcium-active transport pumps moves calcium from the sarcoplasm back into the sarcoplasmic reticulum, where calsequestrin, a calcium-binding protein, removes the calcium out of solution, allowing even more calcium to be sequestered within the sarcoplasmic reticulum. This mechanism is so effective that the calcium concentration is 10,000 times lower in the sarcoplasm of a relaxed muscle fiber than it is inside of the sarcoplasmic reticulum.

The Architecture of Muscle

Muscle is highly organized not only at the microscopic level but also at the gross morphological level. Skeletal muscle is part of a complex bone, ligament, and tendon system that must function as a unit according to biomechanical laws (Lieber and Friden, 2000). Even though muscle and associated tissues are very similar across the animal world, the entire system must be designed to function effectively as a unit in each specific organism type. Understanding muscle architecture requires a knowledge of structural properties that dominate the function of whole muscle sets (Lieber and Friden, 2000). Similarities and differences that exist are primarily a result of biomechanics, design constraints, and design requirements and not common ancestry.

The Types of Muscle

Only three basic types of tissue contractile systems exist in animals. The first involves actin and other fibers inside of cells that cause cell movement, such as in protozoans. The next type is the relatively unspecialized contractile cells in sponges and in certain more complex animals (Dorit, Walker and Barnes, 1991, p. 214). The last type is the muscle system covered in this paper. These three systems are very different, and no evidence of evolution from one to the other exists. Furthermore, no empirical evidence of muscle evolution exists, although many studies have been completed attempting to show homology between different muscle forms (Itina, 1979; Johnston et al., 2004; Laing et al., 1995; Meedel et al., 1997; Fukuzawa et al., 2001; McGuigan et al., 2004; Ferry-Graham and Lauder, 2001; Clayton et al., 1988; and Gibson, 1986). While some variation exists, all known muscle types are as complex as the system discussed in this paper.

Built-in flexibility for certain traits, such as muscle fiber size, is required for an animal to adapt to specific environmental changes. Johnston et al. (2004) found evidence that although regulation of myotube production in fish is under high selection pressure, an optimal fiber size exists that varies directly with body size. This optimal size is the result of a trade-off between mechanical and other constraints on fiber diameter and the energy costs necessary to maintain the required ion gradient level. This finding helps us to understand how life can adapt to various environments, but only within certain limits. Contrary to the claims of some, this is not evidence of macroevolution, but evidence for a designed system that allows for adaptation to limited environmental changes.

Some researchers have tried to use muscle differences that exist for clearly functional reasons to speculate about evolutionary histories. Hoh (2002), in a study of comparative vertebrate muscles, included speculation about possible muscle evolution. He openly admitted, however, that this is only suggestive and is not based on direct evidence. Mastropaola (2001) found no evidence of muscle evolution in a mathematical analysis of the maximum-power stimulus theory of muscle development but rather found evidence for design. He concluded that the "human muscle was meticulously nanoengineered by a designer" and that the "reasonable conclusion from science is that muscle and all other living tissues were designed" (Mastropaola, 2001, p. 219).

The Fossil Record of Muscle

Although soft tissue does not preserve well in the fossil record, muscle tissue is preserved effectively in several situations, such as in amber samples of insects. Amber has been shown to aid in preserving details down to the cell ultrastructure, including the structure of cell organelles (Henwood, 1992). Soft tissues, "especially flight muscle," are frequently preserved in Dominican, amber-entombed animals (Henwood, 1992). Dominican amber is usually assigned from the upper Eocene to the lowermost Miocene.

Muscle fibers also have been found in insects trapped in Baltic amber that are believed to have "formed about 40 million" years ago (Poinar and Hess, 1982, p. 1241). Insects have "a complex musculature, possessing approximately twice the number of muscles as do mammals" (Grimaldi, et al., 1994, p. 7). Evaluation techniques of tissue entombed in amber are still imperfect, but continue to improve. The clearly defined muscle bands and other structures studied so far "resembled present-day tissues that had been dehydrated with ethylene glycol," the solution used to preserve the tissue (Poinar and Hess, 1982, p. 1242).

Muscle tissue also can be effectively preserved in animals caught in tar pits or frozen in ice. Some evidence now exists of muscle preservation in dinosaurs. Soft tissues have been identified in dinosaur bones that reportedly are nearly 70 million years old (Wilford, 2005; Nance, 2005). A nine-inch-long baby Theropod found in a limestone bed near Naples, Italy contained muscle tissue in the pectoral area (Dal Sasso and Signore, 1998).

In a process not yet fully understood, "gill and muscle tissue and even the cell nuclei of ... fish which are 120 million years old, can be preserved by phosphate minerals" (Palmer, 1994, p. 17). Not only were blocks of muscle tissue found, but individual muscle fibers were identified as well. In one study the most published finding was of "soft, fresh-looking tissue inside a T. Rex femur" including blood vessels constructed out of smooth muscle (Yeoman, 2006; Fields, 2006). The research team concluded that the "vessels and contents are similar in all respects to blood vessels recovered from extant ostrich bone" (Schweitzer, et al., 2005, p. 1952).

So far, all of the ancient muscle structures that have been evaluated are close to identical to modern muscle. Henwood (1992) concluded that the small differences between modern and fossil insect flight muscle that have been examined are "best explained by taphonomic circumstances" (p. 206) —in other words, the differences are caused by changes due to the preservation process, such as water loss, and not to evolution of muscle tissue. Bundles of "muscle fibers in their original origins and insertions"—and even Z- and M-lines and T-tubules with a "startling lifelike fidelity—have been identified in many samples of Dominican amber" (Grimaldi, et al., 1994, pp. 1, 7–8, 10). The samples examined so far indicate that the oldest known muscle samples compared with modern samples show that muscle anatomy and physiology have not changed.

Summary

All muscle types in all animals are very similar in structure and function, and all are irreducibly complex machines that must function as part of a complex, well-designed interconnected system as described in this paper. Muscle is part of a very complex system that could have functioned only if every basic component were present from day one. It had to be a fully functional system from the beginning, and without functional muscle very few animals, from insects to mammals, could exist. This fact contrasts markedly to the Darwinian prediction that primitive life used primitive muscle, and more advanced life-forms used more evolved and more complex muscle. No simple muscles exist; rather all muscle in all life, from simple to complex, contains the same components and the same basic design as reviewed in this paper. There is not any evidence for the evolution of muscle in the fossil record. Muscle has always been muscle since its origin in each living kind.

Acknowledgements

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Book Review

The Case for Divine Design: Cells, Complexity, and Creation

by Frank B. Salisbury

Cedar Fort Press, Springville, UT, 2006. 258 pages, $16.00.

This well-illustrated book is one of many excellent new books written in support of both creation and Intelligent Design (ID) by working scientists. The author presents his case in a very reasonable, balanced, and objective manner. Salisbury includes a great deal of excellent material in the area of cell biology to illustrate the evidence for design and irreducible complexity. He effectively shows that everything living and non-living is irreducibly complex, except possibly the fundamental particles such as photons, quarks, and leptons—and even these particles may not be fundamental. If two or more parts are required for something to function, it is irreducibly complex.

The most common argument against irreducible complexity is co-option, using parts already in existence to build new structures. Salisbury shows this does not solve the problem of where the parts come from in the first place. Nor does it solve the problem of the source of the design required to assemble the new mechanism. He also opines that the claim "that an Intelligent Creator would not use parts already in existence when creating some new organisms or biochemical mechanism" is erroneous because "God did indeed do what any intelligent engineer would do in creating some new mechanism: take what was available and modify it" (p. 170). Salisbury adds that when he first encountered this claim, his

> reaction to learning that similar parts were assembled in various ways to accomplish different functions in living organisms was that it provided great insight into the nature of God. He must be an efficient engineer. All of which puts me right back there with Carolus Linnaeus in the eighteenth century as he tried to discern the mind of God from his creations (p. 167).

Salisbury has impeccable credentials including a Ph.D. in plant physiology from Cal Tech. He was professor of biology and plant physiology and was the department head at Utah State University for many years. A leading researcher in his field of plant physiology, Salisbury has published widely in the peer reviewed literature. He has authored several college level botany texts, and several leading college textbooks in plant physiology with major textbook publishers. His publications in *Nature* and *Science* show that ID supporters have published in the peer reviewed scientific literature, contrary to Judge Jones's claim in the Dover case. Some of Salisbury's writings openly argue for intelligent design or critique neo-Darwinism. The book reviewed is endorsed by Morris Cline, Proffesor Emeritus, Department of Plant Cell and Molecular Biology at Ohio State University.

Salisbury's clear review of cell biology and biochemistry is understandable to the average adult. He shows that the case for Intelligent Design is very strong, and that this is one reason for the often irrational opposition to ID today. ID opponents see this field as serious competition to classical neo-Darwinism, although in articles critical of ID authors often try to imply the opposite. Salisbury concludes that "most everyone who understands modern biology realizes that the origin of amino-acid and nucleotide sequences is a truly serious problem, yet mainstream biologists… ignore the problem by believing that it will some day be solved. They create just-suppose stories and put much more faith in them than… justified. The stories are almost always based on mutations and small steps, but there are good reasons for doubting that this combination can do the job" (p. 171).

Salisbury discusses, not only the scientific evidence in favor of ID, but also the evidence that appears contrary to ID. Although he openly favors ID he does an admirable job of objectively presenting the other side. Salisbury effectively answers many of the common objections to ID, often citing the peer reviewed scientific literature as support. No one can claim to be informed about this complex issue without reading this well-documented book.

One topic covered is the theory that RNA evolved before DNA. Called the RNA world, Salisbury shows that numerous serious problems exist with this theory. He reveiws the various origin of life possibilities, showing that no natural origin of life theory has much potential. Salisbury concludes that it is not the theists who believe incredulous stories, but those who think their "just-so stories solve the mystery" (p. 167).

Salisbury quotes *Webster's Collegiate Dictionary*'s definition of religion: "A cause, principle, or system of belief held to with ardor and faith" (p. 177). He then notes that this definition covers the beliefs of many neo-Darwinians. As evidence, Salisbury discusses in detail modern cellular and molecular biology, noting that

> such systems are consistent with an Intelligent Creation. Yet today's high priest of 'The Church of Natural Selection,' Richard Dawkins, vehemently rejects the argument that *complexity* means *design*. We've noted his subtitle for *The Blind Watchmaker*: *Why the evidence of evolution reveals a universe without design*. Yet a reading of Dawkins' books makes it clear that his evidence is for the most part a series of just-suppose stories. Dawkins writes as if such 'evidence' is proof, but when we see that it isn't, we understand that Dawkins is really telling us, and most arduously, about his *faith*. His religion requires much faith…. Dawkins and many others are the theologians of their faith; my faith also has many good theologians (p. 177).

Although the author is a Mormon, the text is totally void of theological content except in one short section and in appendix D where he explains in some detail the Mormon church's position on the creation-evolution controversy. He includes seven pages of notes, eleven pages of references, an index, and an excellent glossary.

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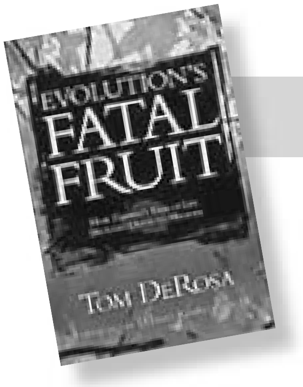

Book Review

Evolution's Fatal Fruit

by Tom DeRosa

Coral Ridge Ministries, Fort Lauderdale, FL, 206 pages, $10.00.

Author Tom DeRosa directs the Creation Studies Institute which is affliated with James Kennedy's Coral Ridge Ministries. This well-written book presents fresh insights into the life and impact of Charles Darwin. Evolution ideas were not originated by Darwin, but his 1859 *Origins* book appeared at an opportune time when naturalism was on a rapid rise in England.

Major book discussion is given to racial prejudice, an essential outcome of evolution theory. This dark side of evolution was championed by many disciples of Darwin including Thomas Huxley, Ernst Haeckel, and Francis Galton. Author DeRosa presents a strong case that eugenics, euthanasia, Nazism, and other social disasters were nurtured by the evolutionary overview.

Tom DeRosa grew up in New York City. He recalls the impact of early visits to the American Museum of Natural History. During teenage years he prepared for Roman Catholic priesthood. Plans later changed and Tom became a high school teacher, and also an eager advocate for evolutionary atheism. Then in 1978, a friend presented the gospel to Tom DeRosa and his life was forever altered. The final book chapter describes the author's testimony.

Tom DeRosa today hosts the *Genesis Connection*, a weekly radio program which features interviews with creation scientists. His contributions to the creation movement are much appreciated. This compact take-along book, just 4x6½ inches in size, will be helpful to many readers. The book has endnotes and a full index.

Don DeYoung
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Notes from the Panorama of Science

Mineral Deposits as an Example of Geological Rates

Since the early to middle nineteenth century, the opinion that slow geological rates operate over long geological periods has dominated the earth sciences. The first estimations of the age of strata were obtained by dividing the visible thickness of strata by the sedimentation rate of modern analogues. Dates many millions of years old were obtained and later thought confirmed by isotopic dating.

Many people therefore believe that all available geological data unequivocally specify an ancient age for the rocks that compose Planet Earth. Hence, the position of evolutionary geology is considered singularly scientific and authentic, and the supporters of evolution try to present the geology of catastrophism as a vestige of a prescientific period in geology. But does this assertion have any real basis in modern science?

More recent research of sedimentary strata and mineral deposits in particular have shown that geological rates are more intense than thought by conventional geologists. Correspondingly, the age of geological objects is much younger than commonly believed.

An example of this is found in research into the rates of formation of mineral deposits and the ages of corresponding geological layers. One of the most basic tasks of geology is prospecting for mineral deposits, and theories are weighed by their success (or lack of it) in the field. The authentic reconstruction of a geological history (and the true rates of geological processes in particular) allows the development of a successful prospecting technique. On the other hand, the incorrect understanding of Earth's history can entail negative economic consequences.

Placer Deposits

Placer mineral deposits are concentrations of heavy minerals (gold, platinum, zircon, various titanium minerals, diamonds, etc.) in modern sediments and consolidated sedimentary rocks. Sometimes it is possible to calculate their time of formation based on the rate of observed modern processes. This reflects the main principle of modern geology–"The present is the key to the past." According to this principle, research demonstrates that coastal marine placers in northeastern Asia must have formed in a few thousand years—contrary to the geological timescale, but in good agreement with the post-Flood duration.

In some cases it is possible to calculate the balance of the placer-forming mineral and then estimate the time of formation of the placer. Such work was done for the Val'kumei submarine tin placer deposit. This placer is located in the coastal zone of Chaun Bay—a shallow restricted gulf of the East Siberian Sea. The source of tin is the Val'kumei granite intrusion, which lies in the coastal zone. According to the geological timescale, the exposure and erosion of the tin veins in the granite began during the Miocene epoch (~25 Ma on the geological timescale). Modern marine environments supposedly appeared about 5 Ma. Given the volume of tin in the deposit, the rate of erosion, the concentration of tin in the source, and also having considered the destruction of placer particles as well as the transport of tin from the zone of the placer (these losses are insignificant, since the bay is geographically restricted and exhibits low wave energy), we can calculate the time necessary for placer formation. Generally, this task is similar to that of calculating the time needed to fill a pool with water, if its volume and the fill rate are known.

Calculations demonstrate that this deposit, which was emplaced under nearshore marine conditions, could be easily generated over 2,000–4,000 years, instead of 5 million (Lalomov and Tabolitch, 2004). Further refinement of the data might adjust the age range, but it is clear that the sedimentologic age is vastly younger than the stratigraphic "age." Furthermore, an examination of the geological materials shows no evidence of significant past variation in the depositional rate or of the tin source (Lalomov, 2003).

Iron-Manganese Nodules (IMN)

At the bottom of modern seas and oceans are rounded balls or crusts composed of oxides of iron, manganese, and other metals. Economic recovery of these minerals is very recent, but their projected volume is huge and future mining of IMN will have a large role in the world's economy.

The rate of IMN formation depends on the rate of growth of the nodules. This factor must play an important part in the economic recovery of IMN as well as theoretical models of the past. Is it possible to measure that rate? Frequently IMN are formed around fragments of shells, shark teeth, and even micrometeorites. The nodules grow as oxides and hydroxides of metals contained in sea water and begin to accrete on these particles. If it were possible to determine the age of the nucleus, we could then divide the thickness into this age and derive a growth rate of the nodule (assuming a regular continuous growth).

Originally, estimations of the growth rates of IMN were made on the basis of dating by ^{224}Ra contained in fragments of shells inside the nodules. Using this method, the growth rate was determined to be between 1 mm in 1,000 years (0.001 mm/yr) and 1 mm per 100,000 years [0.00001 mm/yr] (Mero, 1967). The use of paleontological data (dating fossils in the nodule nuclei) gave comparable results, which is not surprising since the same radiometric analyses underlie the general dating of fossils.

However, another method to measure growth rates has become available in recent years, and this method has the advantage of direct dating. During the study of bottom sediments, researchers have found nodules that formed on the splinters of shells dating from World War I and World War II (Mero, 1967). In these cases the measured growth rate ranged between 0.6 mm/yr to 1 mm/yr. That is between three and five orders of magnitude higher than the rate derived from radiometric and paleontological methods. Moreover, Russian geologists discovered nodules growing on a stainless steel screw and on the cap from a bottle of the Finnish beer "Karjala" (Zhamoida and Grigoriev, 2005). Since most IMN usually do not exceed 30 cm in diameter, the observed growth period can be no more than a few thousand years.

This rate is supported by observed IMN growth in man-made ponds of Siberia, and exceeds 1.7–1.8 mm/yr in those ponds. In the lakes of the Karelia Isthmus, that rate is up to 5 mm/yr. Laboratory experiments have demonstrated that iron bacteria can form micronodules within a few weeks (Tscherbov and Strakhovenko, 2006).

It is likely that the growth rate of IMN is not uniform everywhere. Instead, the growth of each nodule probably depends on the concentration of basic nodule-forming components in the water column or within the bottom sediments, and also on electrochemical and biological properties of the nuclei on which the oxides of iron and manganese are deposited. But the fact remains that growth has been directly observed, and that in these cases the rate is significantly greater than that estimated by isotopic and paleontologic methods. Thus, the conventional ages assigned to IMN are undoubtedly much too high.

This implies that the "absolute" ages of the geologic timescale, relying on evolutionary paleontology and radioisotope dating do not reflect the true ages of these deposits, overestimating them by several orders of magnitude. This not only distorts the geologic history of our planet, but also distorts the economic analysis of mineral resources. From observed growth rates, it appears that IMN are a renewable resource that can be formed in a relatively short time. The same rates strongly suggest that the ocean bottom is no more than a few thousand years old.

Petrol and Gas

There is no need to explain the importance of petroleum. This resource has driven political and economic trends for decades. Even if controlled nuclear fusion (thermonuclear synthesis) is possible, in the opinion of the Russian Nobel Laureate (Physics) Jores Alferov, industrial thermonuclear power stations are not feasible earlier than the mid-twenty-first century. Other alternative energy sources cannot play an essential role on the scale of demand, and thus hydrocarbons must remain the main source of energy for our civilization for some time to come. Given this context, the rate of hydrocarbon generation is far from being a question of simple scientific curiosity.

The "organic" theory of petroleum now prevails. According to this point of view, petroleum and gas have a biogenic origin. They were formed from dead organisms, long buried in the crust, and converted by heat and pressure into hydrocarbons. Subsequently formed oil and gas migrated through permeable rock units and collected in geological structures or other traps. According to this point of view, the formation of hydrocarbon deposits requires millions of years or more.

One problem with this model is the persistence of elevated reservoir pressures over long periods of time. In real conditions it is difficult to imagine sedimentary rocks remaining so impermeable for so long. Given millions of years, one would expect these pressures to equilibrate in the subsurface, even in rocks of very low permeability. In natural conditions, oil and gas usually are under high pressures (the major lifting mechanism to transport oil and gas through wells to the surface), and this may rightly be considered an argument for the young age of these deposits.

Experts in petroleum prospecting note the impossibility of creating an effective model given long and slow oil generation over millions of years (Petukhov, 2004). In their opinion, if models demand the standard multimillion-years geochronological scale, the best exploration strategy is to drill wells on a random grid. The creation of an effective prospecting model is only possible if a recent origin is assumed. Several lines of evidence support this conclusion. First, there are many examples of reservoir replenishment occurring on the scale of decades, not millions of years (Dmitrievsky and Valyaev, 2002). Second, the ability to measure the radioactive isotope ^{14}C in oil and gas requires a much younger age for these hydrocarbons (Barenbaum, 2004; Baumgardner et al., 2003; Doughty, 2006).

If the formation of petroleum and gas deposits really has occurred over tens to hundreds of millions of years, it would seem impossible to measure the replenishment of reservoirs over a scale of a few years. However this phenomenon is real. Also, the presence of short-lived cosmogenic isotopes in these hydrocarbons is evidence for a much more recent formation (less than 40,000 yrs) and an indication that hydrocarbon generation continues today.

Conclusion

Thus, numerous data on the rates of formation of sedimentary strata and mineral deposits present significant discrepancies with the standard geochronological scale. Not only do these data show us that the standard understanding of Earth history is distorted, but also that the old-age model does not provide the basis for sound economic prospecting of mineral resources. This only confirms experimental work that calls the standard stratigraphic models into doubt (Berthault, 2002). Since the standard model does not explain modern observations, it should be considered an atavism of the seventeenth to nineteenth centuries. This conclusion follows both from numerous sedimentological facts as a whole, and from a science of mineral deposits in particular. The available old-earth geochronological scale is closely connected with the evolutionary hypothesis of the origin of the universe, solar system, life, and biological variety on our planet. If the timescale is not correct, then the hypothesis of evolution will have lost the necessary time for evolutionary transformation and must also be considered false.

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Homo floresiensis: "The Hobbit"

In recent times, fossils have been discovered on a tiny island in Asia and given the name of "hobbits" after the little folk from J.R.R. Tolkien's *The Lord of the Rings*. The female originally discovered is just over one meter tall. The brain size is 380 cubic centimeters, which is around that of a chimpanzee. The teeth are larger than human teeth, and the mouth is bigger than ours. Its legs are short with curved thighs, and it resembles *Australopithecus*—but we are told this resemblance is because of its short size and not because it is closely related. Its hands are more humanlike than the hands of *Australopithecus* (Knight and Nowak, 2004, pp. 8–10).

The overall features of the *H. floresiensis* are said to be more like *Homo erectus* than any other hominid, and so is the shape of its brain. The front of the brain is relatively larger than any known adult *H. erectus* (Knight, 2005). The age of the *H. floresiensis* fossils is put at 13,000 years before present (BP) in the evolutionary dating scale, which is quite "young." The big questions concern what these fossils are and where they fit in the scheme of origins.

Perhaps they are nonhumans that walked upright (Brown, 1989). God may have created nonhumans with humanlike walking skills, or these skills could have derived from the genetic potential latent in their "kind." Recently there lived an ape named Oliver who could walk upright all day long with no problem at all (Braid, 2003). *H. floresiensis* may have been such a walking nonhuman.

A second option is that the hobbits derived from a fully-grown *H. erectus* line, which underwent size reduction in order to live on such a tiny island.

Yet *Homo sapiens* may have been involved. It is quite possible that some form of *H. sapiens* is the original type of man. If we use the evolutionists' own dating scale, we have *H. sapiens* going from the present back some 300,000 years BP. At 400,000 years BP we find the world's oldest spears (Dennell, 1997, pp. 767–768). The balance and overall design of these spears are as skillful as our modern ones, and we know that *H. sapiens* were present at this "time." *H. erectus* was not advanced enough before 500,000 years BP to evolve into *H. sapiens*. This leaves no time for *H. erectus* to give rise to *H. sapiens* and points toward *H. sapiens* as being the original type of man.

This also shows there is something wrong with the way evolutionists arrange the fossil record (Brown, 2004). The tools found with the hobbits are not those of *H. erectus* but are sapiens-like. Among them there is something that looks like a spearhead. It is still possible that *H. sapiens* made these spearheads, although there are no signs of him being at this site. We now have a second set of bones, advanced tools, and a dwarf elephant called stegodon with tool marks on its bones (Anonymous, 2005, p. 19). Since *H. sapiens* is still very much absent from the site of these hobbit discoveries, it must lean the evidence in favor of the hobbits themselves having made the tools and having performed the killings involved. If this is so, they could not have gotten these skills from a lower brain capacity and clearly did not receive them directly from *H. erectus*, who apparently never used such tools.

The only option left would seem to be that these hobbits have descended from *H. sapiens*. Something of the sapiens way of thinking perhaps still remained in them—hence the tools. This also would add support for *H. sapiens* filling the time gap between 300,000 years BP and 500,000 years BP mentioned above—if those spears make *H. sapiens* the original type of man.

We have not heard the last of the hobbits. None of these options covered here in any way controverts the creation scenario. Creation can more than encompass any of these hobbit scenarios comfortably.

Acknowledgments: I thank George Howe for editorial assistance and computer typing.

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Letters to the Editor

The policy of the editorial staff of CRSQ is to allow letters to the editor to express a variety of views. As such, the content of all letters is solely the opinion of the author, and does not necessarily reflect the opinion of the CRSQ editorial staff or the Creation Research Society.

Meteor Crater and the Grand Canyon

I read with interest a recent article about a newly discovered meteor crater (Burckle Crater), which is said to lie in the Indian Ocean about 900 miles southeast of Madagascar. Evidence indicated that this crater lies 12,500 feet below the surface and is 18 miles in diameter. By looking at a map, I estimate the location to be about 33 degrees S. latitude, 58 degrees E. longitude. For some time I have suspected that there was a meteor impact in this general region. My reason is that perhaps such an impact may have sent a pressure wave through the earth, producing a bulge on the opposite side of the earth. Fairly close to the exact opposite side of the earth from this crater are the Kaibab and Coconino Plateaus, surrounding the Grand Canyon (36 degrees N. latitude, 112 degrees W. longitude). Perhaps this meteor impact sent such a pressure wave through the earth, rapidly producing such a bulge on the opposite side of the earth; and as the land surface swelled outward it split open an enormous fissure, which allowed water in lakes to the east to flow through it, carving out the incompletely consolidated Flood sediments in this region in a short amount of time, forming the Grand Canyon. Also, of interest is the view expressed in the article that this crater is said to be 4,800 years old, which coincides very closely with the date of Noah's Flood. I seem to recall that on another planet (or satellite) there is evidence of an upwarp on the opposite side of the planet (or satellite) from a major meteor crater. I would appreciate it if some creationist geophysicists, geologists, and planetary geologists could comment on the feasibility of this model.

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Reference

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Rapid Diatomite Formation

David Tyler does well to expose the lingering effects of uniformitarian thinking in current sedimentology (Tyler, 2006). His treatment of the diatomite beds of Cerro Bianco in Peru is persuasive (346 whales found buried to date). However his case for GLOBAL rapid diatomite formation would be compelling by the simple referencing of work done at the world's largest diatomite bed (Lompoc, California), in which *billions* of fossil fish, seals, birds, and yes, even whales (the largest fossil ever found—a 90-ft baleen whale), have been found (Snelling, 1995). When we fail to carefully reference one another's work in areas we publish in, monikers ascribed to us by our secular colleagues apply (Lumsden, 1992).

Mark Armitage

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Erratum

On page 224 of the May 2007 issue of *Creation Research Society Quarterly*, the captions for Figures 1 and 3 were reversed. The caption for Figure 1 should read, "Some examples of trilobites (at top) and Carboniferous Crustaceans (at bottom), illustrating the enormous variety found. (From Le Conte, 1908, p. 411)." The caption for Figure 3 should read, "Examples of trilobites illustrating the enormous variety found. (From Le Conte, 1908, pp. 311 & 334)."

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Creation Research Society

History—The Creation Research Society was organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a need for an association devoted to research and publication in the field of scientific creation, with a current membership of over 600 voting members (graduate degrees in science) and about 1000 non-voting members. The *Creation Research Society Quarterly* has been gradually enlarged and improved and now is recognized as the outstanding publication in the field. In 1996 the *CRSQ* was joined by the newsletter *Creation Matters* as a source of information of interest to creationists.

Activities—The Society is a research and publication society, and also engages in various meetings and promotional activities. There is no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund and research center are maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible. As part of its vigorous research and field study programs, the Society operates The Van Andel Creation Research Center in Chino Valley, Arizona.

Membership—Voting membership is limited to scientists who have at least an earned graduate degree in a natural or applied science and subscribe to the Statement of Belief. Sustaining membership is available for those who do not meet the academic criterion for voting membership, but do subscribe to the Statement of Belief.

Statement of Belief—Members of the Creation Research Society, which include research scientists representing various fields of scientific inquiry, are committed to full belief in the Biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution) both of the universe and the earth with its complexity of living forms. We propose to re-evaluate science from this viewpoint, and since 1964 have published a quarterly of research articles in this field. All members of the Society subscribe to the following statement of belief:

1. The Bible is the written Word of God, and because it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.
2. All basic types of living things, including humans, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.
3. The Great Flood described in Genesis, commonly referred to as the Noachian Flood, was a historical event worldwide in its extent and effect.
4. We are an organization of Christian men and women of science who accept Jesus Christ as our Lord and Savior. The act of the special creation of Adam and Eve as one man and woman and their subsequent fall into sin is the basis for our belief in the necessity of a Savior for all people. Therefore, salvation can come only through accepting Jesus Christ as our Savior.